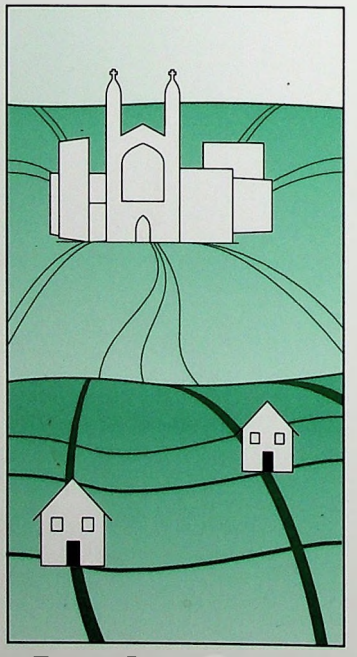
A Cambridge Network project

Cambridge NETWORK

Cambridge 2020:

Meeting the Challenge of Growth



Susan Ablett, Sir Alec Broers
Dr David Cleevely, Sam Cover
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"Innovation is vital to business and wider economic growth. Firms which are successful at innovation will secure competitive advantage in rapidly changing world markets; those which are not will be overtaken by competitors. In today's fast-moving global economy there is an increasing premium on the successful commercial exploitation of new technology; hence the potential importance of technological innovation and R&D."

Innovating for the Future: Investing in R&D, HM Treasury, March 1998

Foreword

Britain's future prosperity rests on the ability of its research and industrial base to generate and exploit ideas with market potential. I believe that Cambridge – one of our most historic cities – is leading the way in building that prosperity.

Cambridge is already renowned as the site of one of the world's leading research universities, with an 800-year history of producing ideas that change the world. In addition, it hosts the greatest concentration of high-tech activity in Europe, focusing on two sectors which will be at the heart of the global economy in the next millennium: biotechnology and information and communication technology (ICT).

I believe that Cambridge has the potential to be at the heart of Britain's competitive advantage in global markets. However, this potential is constrained by the degree to which further growth and development can be accommodated without threatening the unique character of the city and the quality of life of those living in the region.

This report seeks to help reconcile these requirements by highlighting how ICT can be used to minimise the impact of growth on the physical environment while distributing the advantages of growth across a broad area. I hope that the examples the report presents, and the recommendations it makes, will benefit planners, policy makers, local residents and businesses, and ultimately the regional and national economy.

Sir Alec Broers
Vice Chancellor, University of Cambridge

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Professor Marcial Echenique is Professor of Land Use and Transport Studies at the University of Cambridge and is well known as an international expert in urban and regional planning. He is currently directing 'Cambridge Futures', a research project sponsored by a consortium of local politicians, government officials, businesses and academics, to look at development options for the Cambridge region over the next 50 years.

Dr Hermann Hauser has been active as a entrepreneur and venture capitalist in the Cambridge region for 20 years, specialising in ICT-related businesses. Among his many achievements, he has helped to found Acorn Computers, Advanced Telecommunications Modules Ltd and Net Products Ltd. He now oversees Amadeus Capital Partners, a venture capital company focusing on early-stage UK-based technology companies with global potential.

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1/ A Local and a Global Challenge

"Incomparably beautiful in many things, miserably defective in others, [but] still one of the most pleasant places on earth to live."

William Holford, Professor of Town Planning at the University of London, describing Cambridge in 1950

"The challenge is to produce a land use planning strategy which allows Cambridge high-tech companies to fulfil their potential for the benefit of the national economy, and reconcile that with the infrastructure constraints and the need to protect the environment."

John Lambert, Regional Director, Government Offices for the Eastern Region, December 1997

For the last 50 years, Cambridge's planners, policy makers, residents and workforce have been engaged in a debate. The motion being debated is: "This House believes that Cambridge is full". For many years, the proposers of this motion have a fought a largely successful campaign to protect Cambridge's architectural heritage and its Green Belt land from further development. This has been achieved primarily by diverting population growth into the neighbouring South Cambridgeshire District Council (SCDC). Now that local authority has signalled that it too has had enough: in late 1997, SCDC rejected a high-profile planning application by the Wellcome Institute, the organisation working on the Human Genome Project, to create a science park on land adjacent to its current site.

While this rejection was consistent with SCDC's planning guidelines, the idea that a local authority should restrict the work of such a globally important project shocked many people in Cambridge's high-tech community (comprising academics and workers in information and communication technologies, plus the emerging cluster of expertise in biotechnology). The SCDC decision highlighted a major threat to Cambridge's position as a world-leading centre of excellence in the ideas and technologies that will drive the economy in the 21st century. The threat derives from the concern of the local population that Cambridge's unique ambience – and their quality of life – is being destroyed in a push for growth. According to SCDC, the problem is not high-tech development *per se*, but rather the need for additional housing that comes with it. The net effect, however, is a belief that the local economy cannot sustain current levels of growth without the character of the area being radically changed for the worse.

This threat has been noted by the 'opponents' to the "Cambridge is full" proposition, who have recognised its implications for the future prosperity of the city and the wider region. However, a major difficulty for them is that most are themselves in favour of protecting Cambridge and preserving their quality of life. In common with the "Cambridge is full" lobby, they recognise that there is much in Cambridge and its environs which is worth preserving, such as its green spaces, beautiful architecture and pretty villages. However, they also believe that the flowering of high-tech innovation that has taken place within and around Cambridge needs preserving and that it needs space and light-handed regulation to achieve its potential.

The rejection of the Wellcome Institute's planning application (and other applications by the Babraham Institute and Scientific Generics) made the issues relating to Cambridge's future visible to a broad audience. However, for some members of the local high-tech community, the real watershed was the visit paid by a senior delegation of the Malaysian government to the UK earlier in 1997. During this visit, the Malaysian Prime Minister, Dr Mahathir Mohammad, explained that Malaysia intended to build an economy for the 21st century based on the high-tech sector through the construction of a centre of excellence. Mahathir's visit was to promote the Multimedia Super Corridor (MSC), the 750km² high-tech development zone which is at the heart of its global ambitions.[1]

During the Malaysians' visit, several leading members of the Cambridge business and academic community realised that, without support and direction, Cambridge's long history of science-based research and innovation might be eclipsed by the scale and ambition of initiatives such as the MSC being initiated by a number of governments worldwide. Discussions within this group identified two crucial, but apparently conflicting, goals:

- as the site of the greatest concentration of high-tech activity in Europe, Cambridge must exploit its position to become a global player in the high-tech sector
- Cambridge and its environs must preserve the architectural and environmental heritage and the quality of life enjoyed by its residents.

The obvious means of reconciling these goals is to distribute the growth associated with the first goal across a wider geographical area. This has already been attempted in the 1980s and early 1990s through the Cambridgeshire Dispersal Strategy, but three factors restricted the scope for this:

1 http://www.mdc.com.my/msc/index.html

- the fragmented administrative framework in which planning decisions for the whole region were made
- the environmental impact of distributing growth, in terms of increased traffic, more development and encroachment into the countryside
- the reluctance on the part of high-tech companies to move away from Cambridge.

However, the influence of all these factors is now being reduced by new developments.

A new regional administrative structure

Regional Planning Guidelines (RPG) are the responsibility of central government, in consultation with Regional Planning Conferences: one for Norfolk, Suffolk and Cambridgeshire (SCEALA) and one for Hertfordshire, Essex and Bedfordshire (SERPLAN). On the basis of new RPGs, which will be agreed in 1999, the County Councils will produce their Structure Plans, from which the District Councils produce local plans.

However, responsibility for economic development strategy for the 'Eastern Region' (defined as the six counties of Bedfordshire, Cambridgeshire, Essex, Hertfordshire, Norfolk and Suffolk) was recently handed to a new government body, the Regional Development Authority (RDA). The RDA is directly accountable to the government, but will consult with an elected Regional Chamber from April 1999. It is possible that the RDA and the Chamber will ultimately become a new top tier of directly elected regional government and might therefore take on responsibility for planning, although that is not an immediate, or certain, prospect.

Technological solutions to minimise the environmental impact

Advances in information and communications technology (ICT) mean that it is now possible to substitute many of the physical networks which would previously have been needed to distribute growth across the region with digital communications networks. ICT can thus be used to both relieve the pressures associated with growth within Cambridge and its environs, and to build links to the wider Eastern region, with the aim of complementing the conventional transport network. Moreover, the region is well-positioned to carry out ICT-related initiatives, building on the knowledge and expertise which local companies already possess in areas such as telecommunications, Internet technology and information services.

Technological solutions to encourage dispersal

Advances in ICT also mean that many of the drawbacks which have deterred high-tech companies from locating away from Cambridge can now be overcome. ICT creates alternatives to physical collocation in the shape of email, videoconferencing and collaborative working. These alternatives were not affordable – or available – even in the early 1990s.

It is the intention of this report to show how, in the light of these changes, Cambridge can build on its success and act as a 'growth pole' for the surrounding region. This opening chapter summarises the current nature of high-tech activity around Cambridge and its impact on the economy of the Eastern region, and compares some indicators of Cambridge's performance with two major competitors, Silicon Valley and Sophia Antipolis. It then describes the historical context by examining the influence of two seminal post-war reports on Cambridge's development. Lastly, it looks at how continued development in the 1990s is creating even more pressure on Cambridge.

Chapter 2 discusses how ICT can be used to exploit new methods of delivering services, such as education and healthcare; to explore new ways of working and doing business; and to ameliorate common problems such as pollution and traffic congestion. It contains a wealth of examples from Cambridge and other cities around the world, demonstrating the huge variety of benefits which can be gained by individuals, companies and society as a whole from investing in this field.

Finally, Chapter 3 provides a number of guidelines on ways in which ICT can be used, in combination with the region's physical and social infrastructure and entrepreneurial culture, to achieve the twin goals described above. It is the hope of the authors that these guidelines will be seen as a contribution to the development of a strategic plan for the region: a plan which has at its core the maintenance and further development of Cambridge as a high-tech engine of economic growth for the region and the UK.

1.1 COMPETING IN A GLOBAL LEAGUE

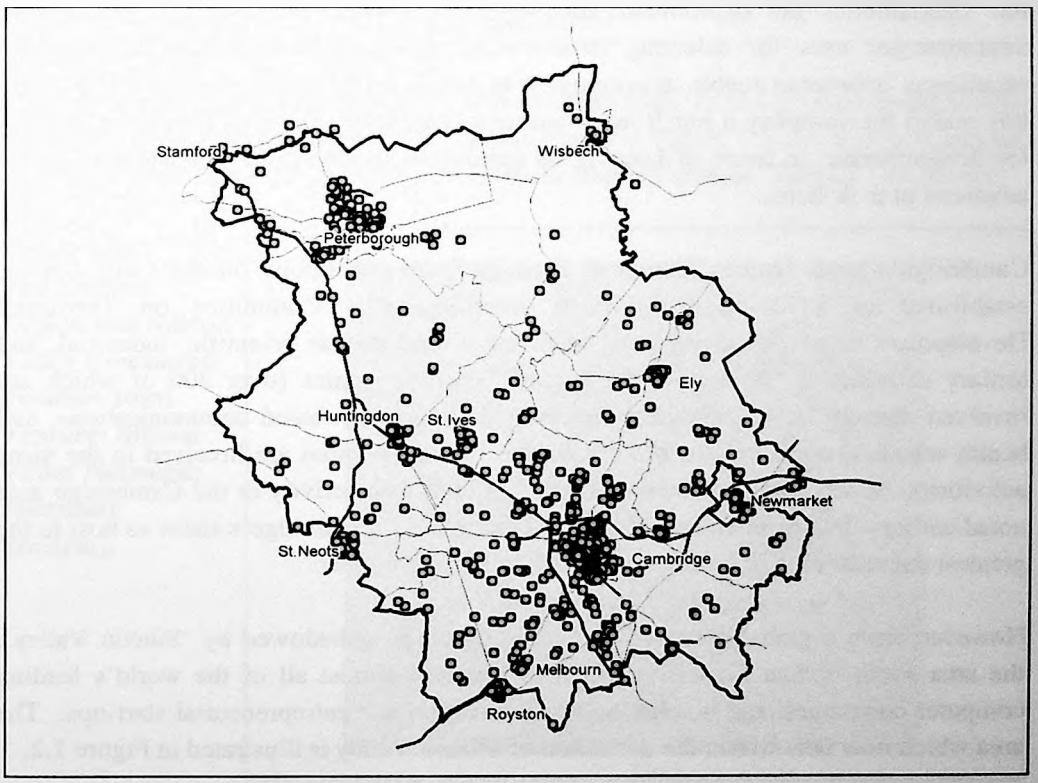
Since the end of the recession in the early 1990s, the Eastern Region has been one of the fastest-growing regions in the UK. It is also one of the wealthiest: its GDP was second only to that of London and the South East in 1995.[2] Much of this growth has been fuelled by the intensity of high-tech activity in and around Cambridge, which can be demonstrated by a number of indicators, including the fact that the Eastern Region

[2] Department of Trade and Industry (1998).

spends 3.7% of regional GDP on research and development, compared to, for example, 1.3% of regional GDP in the North East and East Midlands.[3]

In 1996, the latest year for which statistics are available, 892 high-tech companies, employing some 28 000 people, were registered as operating in Cambridgeshire.[4] Figure 1.1 shows the distribution of these companies across the county. These firms employ over 8% of the 340 000 labour force in the county. In contrast, for the UK as a whole, high-tech employment represents only 3% of the workforce. Even in the London and the South East, it accounts for less than 5% of the workforce.[5] A more detailed exploration of the composition of Cambridge's high-tech sector is provided in Annex A.

Figure 1.1/ **Distribution of High-tech Companies in Cambridgeshire, 1997 [Source: Cambridgeshire County Council Research Group].**



3 http://www.local-regions.detr.gov.uk/bpp/chap13a.htm

4 The figures quoted are taken from Gonzales-Benito *et al* (1997). However, Cambridge Econometrics puts this figure much higher, at 50 600 in 1995 and a forecast 56 200 in 2000.

5 Department of Trade and Industry (1998).

The origins of this concentration of high-tech companies lie in Cambridge University's 800-year history of producing ideas which change the world. This spans the whole spectrum of intellectual activity; the following list cites some of the achievements which are particularly relevant to the fields of information and communication technologies:

- Babbage invents the 'calculating engine' (1812)
- Wilkes develops the first digital computer (1949)
- Wilkes builds the first fixed cell network for data communications (1974)
- Friend and Holmes discover light-emitting polymers (1989).

One of the reasons which has often been cited for the continued success of the University as a breeding ground for innovation in pure and applied science is the proximity within which its academics live and work. It is a feature that has also attracted many companies to Cambridge. For example, Reid Smith, Vice President and Director of Schlumberger Cambridge Research, which provides products and services to the international oil exploration industry, emphasises that one of the criteria Schlumberger uses for selecting locations is proximity to a centre of academic excellence, in order to enable its employees to pursue dual careers. According to Smith, this makes the company a much more attractive employer, and also has major benefits for Schlumberger, in terms of keeping its employees in touch with the latest academic advances in their fields.

Cambridge's most famous European rival is Sophia Antipolis on the Côte d'Azur, established in 1972 by the French InterMinisterial Committee on Territorial Development as a science park to "host public and private scientific, industrial, and tertiary activities".[6] It is now the site of 1050 companies (over 300 of which are involved directly in information sciences, electronics, advanced communications, and health sciences) and some 16 000 employees (8000 of whom are involved in the same activities). When compared with the level of high-tech activity in the Cambridge area noted earlier – 892 companies and 28 000 employees – Cambridge's status as host to the greatest concentration of high-tech activity in Europe is clear.

However, from a global perspective, Cambridge is overshadowed by 'Silicon Valley', the area south of San Francisco which is home to almost all of the world's leading computer companies, and is a hot-bed of innovation and entrepreneurial start-ups. The area which now falls within the definition of Silicon Valley is illustrated in Figure 1.2.

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6 http://www.saem-sophia-antipolis.fr

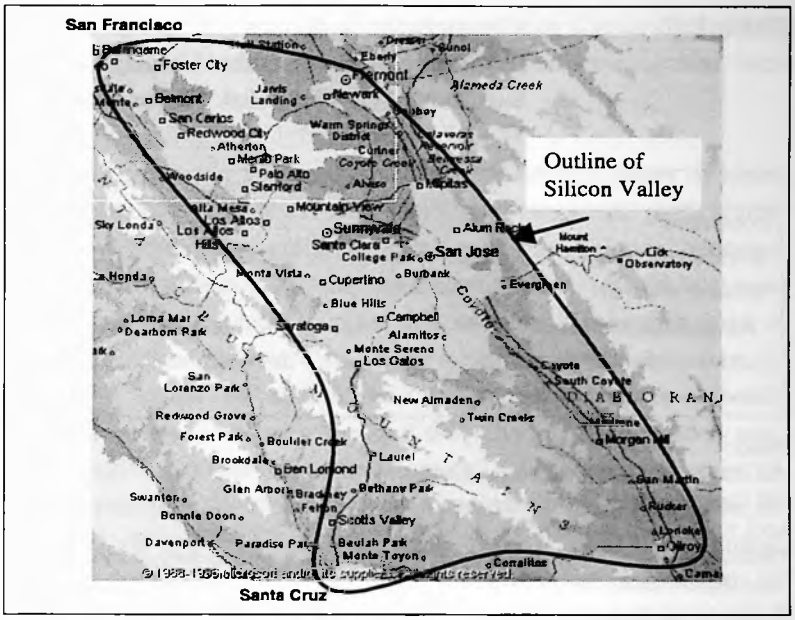

Figure 1.2/ Extent of Silicon Valley [Source: Joint Venture: Silicon Valley Network; Microsoft Encarta].

The concentration of high-tech activity around Cambridge is not only on a much smaller geographical scale than Silicon Valley, as illustrated in Figure 1.3, but is also much less significant when measured according to a whole range of criteria (Table 1.1 overleaf).[7]

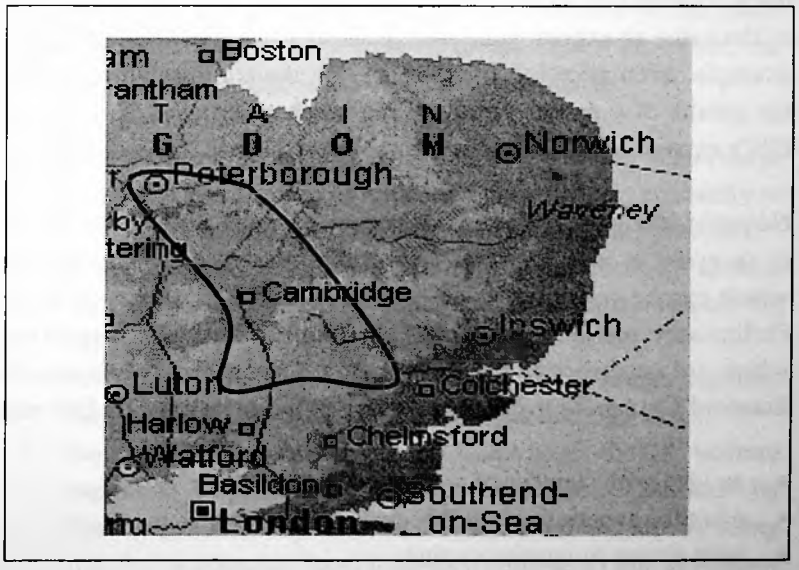

Figure 1.3/ The Eastern Region and Silicon Valley Compared [Source: Joint Venture: Silicon Valley Network; Microsoft Encarta].

[7] Note that the positioning of the shape of Silicon Valley in Figure 1.3 is arbitrary. It would be possible to retain the same total area but change the shape of the area and take in Norwich, or Ipswich, or some other geographical grouping.

Table 1.1/ Comparative Indicators, Silicon Valley and Cambridgeshire [Source: Cambridgeshire County Council; GOER; Gonzales-Benito *et al* (1997); Joint Venture: Silicon Valley Network; World Bank (1997)].

	Silicon Valley	*Cambridgeshire*
Population	2.3 million	703 000 (1996)
Workforce employed in high-tech sector	480 000	28 000
Value of exports:		
region, high-tech sector	$39.7 billion	$1.2 billion*
national, total (1995)	$969 billion	$458 billion
New business starts in the high-tech sector†	3575	87 (1994/95)

Notes:
All data is for 1997 except where stated.
All Cambridgeshire data includes figures for Peterborough, even though this became a unitary authority on 1 April 1998, and therefore no longer falls under a strict definition of Cambridgeshire.
*Estimate based on a 1996 survey of 569 companies by Cambridgeshire County Council.
†The figure shown for Silicon Valley is actually just for Santa Clara county and so the total for Silicon Valley would be higher; anecdotal evidence suggests that the figure for Cambridgeshire is now rising.

While it is clear from Figure 1.3 and Table 1.1 that there is a huge difference in scale between Cambridgeshire and Silicon Valley, the data needs to be treated with some caution due to different definitions of the high-tech sector. Nevertheless, it is possible to draw some useful indications of the relative competitiveness of the two regions in terms of the value of exports generated, number of people employed and average salaries. For example, even allowing for the fact that the Cambridgeshire export figure is based on the results of a partial survey of high-tech companies, the county's contribution to the UK's exports still falls a long way short of Silicon Valley's contribution to US exports.

However, the most important difference between Silicon Valley and Cambridge's ability to compete in a rapidly-evolving global market relates to the last entry in Table 1.1, which can be construed as an indication of the existence of an entrepreneurial culture. Preliminary research conducted by Stanford University to investigate the conditions which are necessary to the success of a Silicon Valley start-up, and the role played by Stanford University in creating those conditions, identified five requirements:[8]

- an idea with significant market potential
- a highly-experienced, highly-dedicated team
- easy access to venture capital
- 'appropriate infrastructure'
- high quality of life available in the area.

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8 James F. Gibbons, Frederick Emmons Terman Professor of Engineering and Dean of the School of Engineering at Stanford University, in a presentation which he made via video link-up to Cambridge Network members in March 1998.

In order to understand the nature of the competitive challenge facing Cambridge and the Eastern Region, it is instructive to consider how Cambridge performs against these criteria.

Ideas with market potential and experienced dedicated teams

Cambridge people and companies have generated plenty of ideas with market potential. Where they have been weak, particularly in the last twenty years, is in creating the balance between innovative brilliance and entrepreneurial talent, i.e. the business skills required to take an idea and successfully exploit it in a global market place. Cambridge's deficiency in this area is partly a result of a lack of suitable role models – local entrepreneurs who have bridged the divide between idea and exploitation. There are also relatively few large companies in the Cambridge area producing experienced managers able to support an entrepreneurial company in the pursuit of its goals. In contrast, Silicon Valley entrepreneurs have succeeded in drawing together teams which were capable of turning a good idea into a product or service with a global market.

Access to venture capital

Neither the UK nor Europe have historically used venture capital as a source of finance. While the UK is now the largest venture capital market in Europe, accounting for over 50% of the funds invested, it is still small compared to the USA. However, the situation in Cambridge is slowly improving, due to:

- organisations such as CRIL, Prelude and the Cambridge Quantum Fund which provide seed corn finance, primarily to companies spinning out of university research departments.
- venture capital companies like 3i and the recently created Amadeus venture capital fund, which is partly funded by Microsoft
- the Great Eastern Investment Fund, which brings together business angel investors interested in technology firms
- the co-ordinated marketing of Cambridge to US venture capitalists, including an analysts' tour organised by Cambridge Network Ltd, an organisation set up to bring together academics, local high-tech companies and investors.

Appropriate infrastructure

The Stanford research uses the term 'appropriate infrastructure' to refer to a number of disparate issues:

- the presence of research universities doing relevant work and educational institutions delivering a good pool of labour (with both technical and business skills) at all levels
- availability of inexpensive office and laboratory space with high-quality ICT infrastructure
- access to support services (such as lawyers, public relations and marketing agencies) and technical services, making it possible, for example, to commission prototypes from external contractors, instead of having to create everything from scratch in-house
- a culture that views business failure as a way of gaining valuable experience on which subsequent successes can be built.

Cambridge scores well on some educational aspects: for example Cambridge University produces 1500 graduates a year in computer science, electrical and information sciences, and engineering (including manufacturing and chemical engineering), and more than 450 PhDs in the same disciplines. The Cambridge high-tech sector is also closer in spirit to Silicon Valley's attitude to business failure than the rest of the UK. However, it scores poorly on availability of office and laboratory space and support services.

Quality of life

The quality of life criterion covers the attractions of the location as a place to live and work. While Silicon Valley wins on climate, Cambridge has the benefits of its outstanding architectural and historical heritage.

So if the high-tech sector in Cambridge and the Eastern Region is to continue to flourish, planning policy must place a strong emphasis on creating the conditions which will encourage companies to set up here, remain here, and even migrate here, while simultaneously tackling some of the development pressures which have built up in Cambridge and its immediate environs over the last 50 years, and which have proved such a headache to planners, residents and commercial interests alike. This historical context to Cambridge's current predicament is discussed in the following section.

1.2 THE HISTORICAL CONTEXT

As described in the introduction to this chapter, Cambridge's residents and policy makers have long been concerned that their city is threatened by the pressures of development. Two reports have been crucial in directing thinking on this issue in the last 50 years:

- the **Holford Report**, published in 1950.[9] Its starting point was to keep Cambridge's reputation as a University town of international importance. The team was chaired by Sir William Holford, an eminent architect and planner, with other participants from the newly-formed County Council Planning Department, the (then) Borough Council and Cambridge University. The plan was submitted with modifications by the County Council to the government in 1952 and was largely accepted in 1954. It guided planning controls in the city until the early 1970s.
- the **Mott Report**, published in 1969.[10] The University set up a sub-committee of the Senate in 1967 to consider the planning aspects of the relationship between the University and science-based industry. This report recommended careful relaxation of the policies established in the Holford Report. The committee's recommendations were accepted in the early 1970s and have guided planning ever since.

A summary of the conclusions of these two reports is provided below, before moving on to look at the problems Cambridge faces as it approaches the millennium.

1.2.1 The Holford Report

The Holford report was in the vanguard of the movement to keep Cambridge safe from growth or change. The report, published in January 1950, was quite explicit on this point. Summing up the results of the study, the Holford report concluded "that there should be a resolute effort to slow down migration into the Cambridge district and to reduce the high rate of growth so that the future population should not greatly exceed present figures, is our first and main proposal and permeates all others."

Holford's remit was the town of Cambridge and its surrounding villages. In 1950, this area contained around 104 000 inhabitants. As Holford noted, the population had grown by some 16% over the past decade. His report concluded that "we believe that this rapid growth is likely to continue, and even to accelerate, unless special effort is made to

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9 Holford, W. and Wright, H. M. (1950).

10 Mott, N. F. (1969).

prevent it." The report also put its finger on the two problems that have exercised Cambridge residents and its elected representatives for over 50 years: "If probability of rapid growth is the gravest problem in the planning of Cambridge, the most urgent is that of traffic . . . Traffic has grown tenfold since 1911, but streets remain the same and their surplus capacity is now used up."

In the report, Holford returns again and again to the need to keep Cambridge small. It is Holford who seems to have been responsible for the emergence of the "rule of proximity", which states that face-to-face contact is a vital part of Cambridge's success. In his report, he stated that further growth would diminish the quality of life of both the University's academics and the ordinary Cambridge citizen. Academics would suffer because growth would both disrupt their peace and quiet, and deny them the opportunities for social discourse "so necessary to the furtherance of their work", because of the increased distances involved in travelling between the colleges, the university departments and their homes. For the ordinary citizen the issue was more practical: "three to four miles between home and work would jeopardise a return home for a mid-day meal."

In keeping with its concerns about growth, the Holford report was responsible for a recommendation to keep large-scale industry out of Cambridge. The report was quite specific about this, even to the extent of suggesting that, should a local firm show any signs of expansion, it should be possible to make a distinction between the research and prototype side of its work and actual production in quantity and that the latter should be moved to parts of the country where new employment was needed. Similarly, in the report's chapter on the future size of Cambridge, it acknowledges that the University may need to grow, but states that such growth need not be any more than "... possibly some expansion, in or near Cambridge, of research and prototype work closely connected with the University."

The Holford report certainly did much to preserve the fabric of Cambridge and to retain its character as an historically-interesting site. However, it was the source of the hugely influential belief that growth was bad and that it was the planners' primary duty to preserve Cambridge as an example of an archetypal medieval University town where labourer and lecturer alike enjoyed a leisurely bicycle ride home to lunch every day. It also created a long-lasting distinction in the minds of the town's planners and policy makers between mass production and small-scale, innovative, research-based industry.

1.2.2 The Mott Report

The Mott Report, published in October 1969, was concerned with only one issue – the relationship between the University and science-based industry – but has had a much more far-reaching influence than that might suggest. The view of the Mott report was that Holford had got it wrong, at least as far as the University was concerned. While Holford had aimed to restrict growth, the Mott report was in favour of specific types of growth. With this in mind, Mott recommended a strengthening of ties between the University and local industry, and suggested that this would be most easily accomplished if there were an increase in the number of high-tech firms operating in or very close to Cambridge. In the view of the Mott report, "the type of development likely to interact most closely with the University are new industries which in the initial stages are vitally dependent on facilities already available in the University and which have a high scientific and research content." The links between these two partners would be so close that in many cases the scientists and engineers would be involved throughout the process.

In the light of this new model of the relationship between 'town and gown', the issue of proximity assumed even greater importance. Statements at the report hearings had suggested that there was a marked reluctance on the part of employers to consider areas beyond a five-mile limit from the City, and the reasons for this were reflected in the report: "It becomes increasingly difficult and uneconomic for an industrial research scientist to make a break in his work in order to travel into a university teaching department for a short period of teaching or to supervise the work of a research student, as the travelling time or difficulty of travelling arrangements increases."

Thus, the desired growth had to be close to Cambridge in order to benefit from the proximity effect. The Mott report saw no economic benefit in attempting to graft high-tech development onto centres where there was no existing core of expertise. It argued was that it was best to concentrate scarce and expensive resources in one place where they could be used by the greatest number of people. Thus the report's most innovative suggestion was the establishment of a 'science park' within the city. This idea had the merits of:

- meeting the objective of increasing the number of science-based industries
- strengthening the links between the University and local business
- keeping all development within a five-mile radius.

Moreover, by designating a specific area for development as a science park, the city's planners would be better able to control the types of organisation that set up in Cambridge.

As a result of the report's recommendation, Trinity College founded the country's first science park in 1970 on the northern edge of the city. By January 1998, the park had grown to support 63 companies and over 4000 employees. Following the success of Trinity's venture, several other science parks, including some founded by other colleges, have been built, such as the St John's Innovation Centre.

The report was clear that any growth should focus on research and development: "There will need to be very careful control to ensure that if science-based industries develop to the point of large-scale manufacture, the manufacturing side at least is moved away from Cambridge." In addition, it specified two kinds of science-based organisation that should not be allowed to establish themselves in Cambridge:

- those that established laboratory facilities solely with a view to meeting planning requirements
- those that employed 1000 or more scientists and technicians.

It was this latter restriction which led, for example, to the rejection of IBM's plans to move to Cambridge and set up its research and development facilities there.

Having established the framework for growth, the Mott Report looked at some of the implications, particularly for housing and traffic and included some familiar themes: "The Council [of the University Senate] therefore regard it as most important that additional housing should be provided before there is any additional industrial development, and that similar urgent attention should be paid to the traffic and parking problems which will result from any significant increase in population."

1.2.3 Trends since 1970

It is useful to survey briefly the evolution of Cambridge and Cambridgeshire since 1970 to assess the impacts of planning policies based on the recommendations of the Holford and Mott reports. Key areas in this respect are:

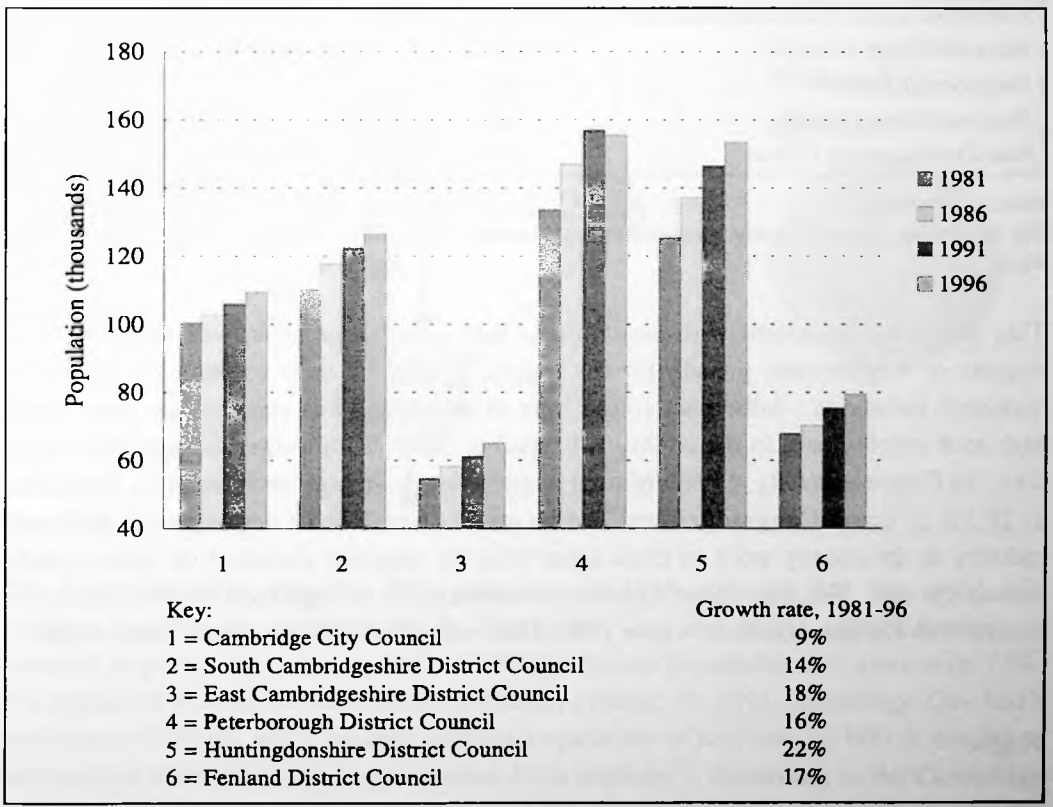
- population
- employment
- traffic
- housing.

Trends in these areas are discussed below, using data from sources such as Cambridgeshire County Council's Research Group, the Department of the Environment, Transport and the Regions, and the Office of National Statistics.

Population

As described above, when development pressures on Cambridge City were adjudged to have become too acute, the natural solution seemed to be to divert growth into South Cambridgeshire. Between 1950 and 1996, the population of South Cambridgeshire doubled, at a time when the population in the City rose by approximately 34% and the population of the UK as a whole grew by only 12%. However, in recent years, South Cambridgeshire has also shielded itself from growth, as demonstrated by Figure 1.4 – the population in Cambridge City and South Cambridgeshire has increased more slowly than in the rest of the county.

Figure 1.4/ Population Growth in Cambridgeshire, by District, 1981-96 [Source: Cambridgeshire County Council Research Group].



Key:	Growth rate, 1981-96
1 = Cambridge City Council	9%
2 = South Cambridgeshire District Council	14%
3 = East Cambridgeshire District Council	18%
4 = Peterborough District Council	16%
5 = Huntingdonshire District Council	22%
6 = Fenland District Council	17%

Employment

Table 1.2 shows the distribution of total employment across Cambridgeshire. The rate of expansion for the county from 1981 to 2006 is forecast to be 40%, with particularly rapid growth in Cambridge City, South Cambridgeshire, Peterborough and Huntingdonshire. However, when compared to population figures above, it is clear that growth in employment in Huntingdonshire and Peterborough will be supported to a much greater extent by increased population than in Cambridge City and South Cambridgeshire.

Table 1.2/ Employment in Cambridgeshire, by District, 1981-2006 [Source: Cambridgeshire County Council (1995b)].

	Total jobs			*Growth rate,*
	1981	*1991*	*2006*	*1986-2006*
Cambridge City & South Cambridgeshire	98 700	121 200	141 400	43%
Fenland District	25 700	28 600	32 200	25%
Peterborough District	67 900	81 200	95 400	40%
Huntingdonshire District	48 600	59 900	69 300	43%
East Cambridgeshire District	17 600	20 800	23 600	34%

Note:
For forecasting purposes, only the Peterborough Southern Township is included in the Peterborough figure

This would be consistent with assumptions that these latter areas will continue to be engines of employment growth for the region, fuelled by their existing dominance in high-tech industries. Adherence to the 'rule of proximity' has ensured that most of the high-tech employment in the county is located in South Cambridgeshire and Cambridge City. In Cambridge City, 12.9% of total employment is in high-tech industry, increasing to 26.3% in South Cambridgeshire.[11] As a result, over 70% of employees in high-tech industry in the county work in these areas with the majority clustered on science parks around the city. The only other significant concentration of high-tech employment in the county is in Huntingdonshire, where 17% of the county's high-tech labour force works.

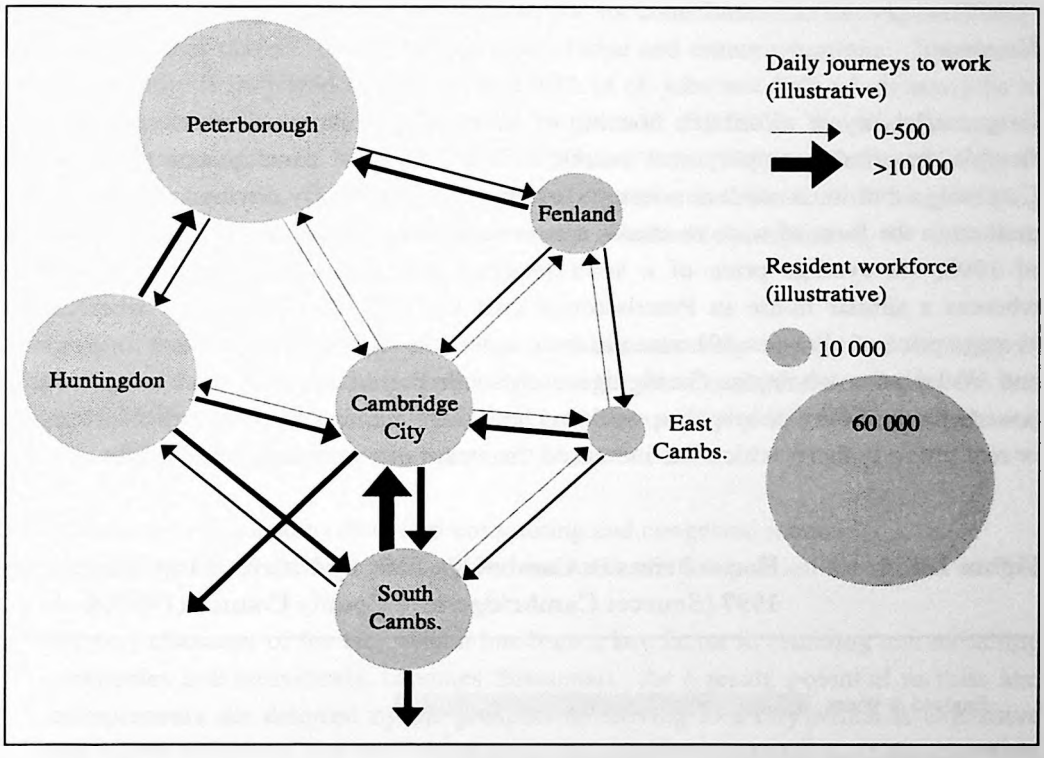
Traffic

Where populations are growing and jobs are being created, there is an inevitable increase in the amount of traffic on the roads. However, the peculiarities of population and employment distribution within Cambridgeshire have led to some particularly striking effects, as illustrated in Figure 1.5, which shows:

[11] Gonzales-Benito *et al* (1997).

- the degree to which South Cambridgeshire residents commute to work in Cambridge
- the degree to which Cambridge City and South Cambridgeshire are isolated from the rest of the county.

Figure 1.5/ **Journeys to Work and Resident Workforces in Cambridgeshire, Selected Routes, 1991 [Source: Cambridgeshire County Council (1995a)].**



The Cambridgeshire Structure Plan published in 1995 assumes that this trend will continue and deepen: employment in Cambridge City and South Cambridgeshire is assumed to grow 43% between 1981 and 2006, whereas population will grow only 23%. The impact of this skewed distribution is already evident. In 1991, Cambridge City had a workforce of 70 000 and a resident working population of just over 40 000: it needed to make up the shortfall by drawing in labour from outside.[12] According to the Cambridge Futures group, this shortfall has led to a five fold increase in commuting into Cambridge and a tenfold increase in congestion on the City's access roads over the last 50 years.[13]

12 Cambridgeshire County Council (1995a).

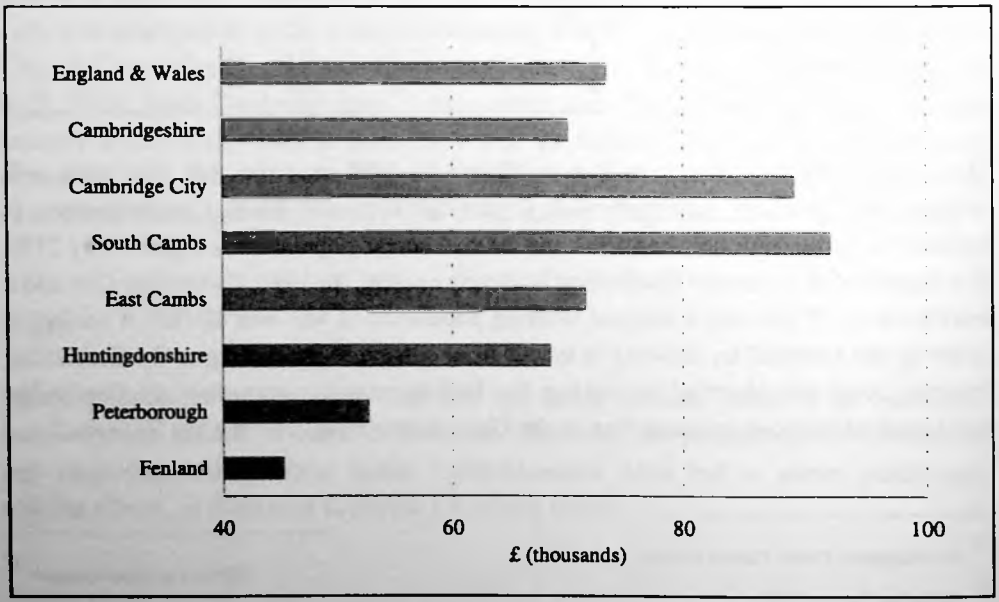
13 Cambridge Futures (1998).

An even more telling indication of the pressure to which central Cambridge's essentially medieval road structure is now subject is offered by data on traffic using Magdalene Street, part of the main North–South route through the city. The Holford report stated that in 1913 Magdelene Street had carried 114 motor and horse drawn vehicles in the peak hour, while in 1950 it carried 400 motor vehicles and 1500 cycles. No recent data is available on peak-hour usage, but in 1997 8164 motorised vehicles and 4679 bicycles used that same street between the hours of 7am and 7pm.

Housing

Easy availability of affordable housing of all types is a necessary pre-condition for a flexible, responsive employment market. The impact of development pressures on Cambridge and its immediate vicinity has become particularly obvious in the housing market, in the form of wide contrasts across the county. For example, at the beginning of 1998, the average price of a semi-detached house in Cambridge was £100 350, whereas a similar house in Peterborough cost just £49 250. Moreover, whereas the average price of all types of houses in the county was slightly less than that for England and Wales as a whole, in Cambridge and South Cambridge it was at least £10 000 pounds more. Many people who work in Cambridge are no longer able to afford to buy or rent property there, which has increased the extent of commuting into the city.

Figure 1.6/ **House Prices in Cambridgeshire, by District, First Quarter of 1997 [Source: Cambridgeshire County Council (1997b].**



1.3 THE CHALLENGE OF GROWTH

The outlook for Cambridge at the end of the 20th century is mixed. Cambridge is host to a concentration of academic and commercial expertise in high-tech fields which is unrivalled in Europe. These fields – particularly information technology, communications technology and biotechnology – will be the key wealth-creating sectors of the economy over the coming years. If its potential can be exploited to its full extent, Cambridge will be a pre-eminent centre in the information society of the next millennium, receiving huge financial returns for its contribution to the exponentially-expanding global market for information, knowledge and communications. The size of this opportunity is indicated by the fact that 50% of all jobs and 80% of all new jobs in Europe now come from information-based services.[14] By 2000, the telecoms sector alone is forecast to account for 7% of all GDP (from 4% in 1984), and indirectly support 60% of all employment. Cambridge's high-tech expertise is at the core of this emerging information and communications based economy. From this perspective, the outlook is rosy.

However, from the perspective of many of those currently living and working in Cambridge and its environs, the prospects are less bright. People are worried by the rate of growth and the impact this could have on both the quality of life for individuals and the ease with which businesses can operate:

- house price rises lead to increased commuting and congested roads
- recruitment becomes more difficult because of acute competition for skilled staff in the city
- the very character of the city, which has been a key factor in retaining and attracting companies and individuals, becomes threatened. As a result, potential recruits and entrepreneurs are deterred by the prospect of moving to a city which is expensive and where education and medical services are under strain because of the increased demands on their resources in a period in which budgets are constrained.

If it appears that further deterioration of quality of life is the inevitable outcome, those charged with ensuring the continued prosperity of Cambridge, the Eastern Region and the UK will find it difficult to make a policy of continued growth acceptable to the electorate. But, given the global marketplace of the 21st century, putting up the shutters is not an option.

Fortunately, Cambridge holds the solution to this dilemma in its hands. Its concentration of ICT companies means that it has immediate access to technological

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14 Graham, S. and Marvin, S. (1996).

innovations which can help to resolve many of the problems associated with growth in two ways.

- **They reduce the need for proximity**. In the past, much economic activity depended on physical collocation. By contrast, ICT provides the ability to communicate and trade easily at a distance via services such as videoconferencing, email and electronic data interchange. This facilitates the distribution of growth across a much wider geographical area without a proportional increase in the number of physical journeys which have to be made.
- **They can deliver a wide variety of services more efficiently** than conventional means, both in terms of reduced cost and in terms of delivery closer to the user or purchaser. These services include teleworking, telelearning, telegovernment, teleshopping and telemedicine.

The potential for ICT to be used to help solve some of the difficult challenges faced by Cambridge is an issue that has captured the attention of a number of different groups. At the end of 1997, the City Council initiated an inquiry into 'Technology and the City', in order to understand more about the potential benefits of ICT. The report of the Committee's findings, which was published in April 1998, included recommendations that the Council should:

- develop a partnership approach to raise public awareness of ICT
- embrace electronic media and new technologies in its own service by developing a city.direct programme (on the lines of the government.direct project), possibly in partnership with the County Council.

This report seeks to add to the existing understanding of the relationship between ICT and the development of the region by surveying the experience of cities and regions elsewhere. In the next chapter, we present a wide range of examples, taken from across the globe, showing how ICT is already being used both as a tool to solve particular problems and as an input to the strategic management of local and regional development. These examples, and the best practice they characterise, then form the basis of our recommendations and guidelines on the role ICT can play in facilitating and making palatable the future development of the region.

2/ ICT – A Key Ingredient

The ways in which ICT can be applied to improve our day-to-day lives are virtually limitless. In order to help the reader navigate his or her way through the plethora of possibilities, the examples of trials and commercial implementations in this chapter are presented into six broad categories:

- teleworking
- telegovernment
- telelearning
- telemedicine
- ecommerce
- smart cards.

Cambridge certainly has much to absorb from the 'best practice' which is developing in these areas. One of the most comprehensive sources of information on developments in ICT applications and technology is the database of the European Commission's European Telematics Horizontal Observatory Service (ETHOS). Many examples in this chapter are drawn from the ETHOS 'Telematics and Technology News' database.[15]

However, applying ICT to individual fields such as medicine or education leaves untapped much of the scope for improvement which ICT offers. Thus, in the final section of the chapter, we discuss the class of 'wired' cities. These cities or regions have decided that, in order to play a leading role in the information economy of the next century, they must first build high-speed networks on which all applications and services can then be provided. By learning from this wide range of approaches, Cambridge can meet its own goals, and those of the region which surrounds it.

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15 See http://www.tagish.co.uk/ethos/news Analysys would like to thank the ETHOS project team for permission to use this source.

2.1 TELEWORKING

Teleworking (or telecommuting) is the use of ICT to work from home or from a satellite office close to home, or while travelling on business, for all or part of the time, instead of commuting daily to a conventional office.

Data from different sources on the take-up of teleworking can be difficult to compare since, for example, some definitions exclude self-employed teleworkers, or teleworkers who do not work at home full time. Nevertheless, reliable indicators suggest that in the USA more than 11 million Americans teleworked from home in 1997 (an increase of nearly 30% on 1995) and that the total is set to rise to more than 14 million by 2000.[16] The European Commission estimates that at least 2 million people currently telework in the European Union, and predicts that this figure will increase to between 10 and 20 million teleworkers by 2005.[17]

Three factors are encouraging the trend towards teleworking:

- **social**: concerns about increasing traffic congestion, pollution and commuting times are encouraging governments, companies and individuals to look at new models of working. Organisations also recognise that business travel has a direct negative impact on their operations in terms of expense and an indirect impact in terms of reducing the efficiency of key personnel.
- **technological**: the convergence of telecoms and computing technologies and the delivery of higher bandwidths to the home are making it possible to telework effectively. In addition, Internet access and Internet telephony are increasing the range of existing jobs which can be conducted away from a centralised office.
- **economic**: the cost of establishing a teleworker is falling rapidly, driven by a combination of a more competitive telecoms market and cheaper and more advanced computing technology. In contrast, the cost of office space, which is often the second or third largest expense for a business, has risen sharply.

Accordingly, the benefits on offer to both employers and employees are substantial. As noted above, the organisation gains from the reduction in office space which it requires, and therefore the rent it pays. Moreover, studies have found that teleworking increases both the number of hours worked by employees and their level of productivity. However, despite this, teleworkers experience greater job satisfaction, because they feel they have greater control over their work, and less conflict between their business and personal life. This produces benefits for the company in terms of lower rates of

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[16] 1997 FIND/SVP American Internet Users Survey. See http://www.att.com/press/0797/970702.bsa.html#facts

[17] European Commission (1997).

absenteeism and sick-leave. Finally, the reduction in the amount of commuting and in-work travel also reduces personal and corporate expense.

The potential isolation of the teleworker can act as a deterrent to adopting this style of work for both the employer and the employee. This is partly related to practical concerns: for example, a teleworker whose computer is malfunctioning may find it more difficult to get effective support from his company's internal IT group than if he, and his computer, were on site. However, the biggest deterrent is generally concern about the implications of distancing the employee from the social (as opposed to physical) infrastructure of the business:

- employees may fear becoming marginalised, either because they feel insufficiently informed about what is going on in the rest of the company, or because they feel their efforts may be overlooked if they are not on-site
- managers may resist implementing teleworking in their departments because they feel it will weaken their ability to control or measure how their employees spend their time.

One of the most promising forms of teleworking, and one which would serve to mitigate this problem of isolation is the creation of neighbourhood 'telecentres', where teleworkers can benefit from on-site technical support services and interaction with colleagues or other teleworkers. These centres can be run either by a single employer for its employees, or as a collaborative or publicly-funded undertaking. The trials and pilots described below should go some way towards demonstrating the rewards which are available.

Davis & Co.

Davis & Co. is a London law firm, founded in 1993. From its inception it has been structured around the use of teleworking and electronic communications technology.[18] All of its 30 fee earners and most support staff telework, each having a PC, printer, modem and fax. Incoming telephone calls are received at one central location and then forwarded to branch offices or teleworkers' private offices. Staff communicate with each other and clients through the Legal Information Network (LINK) which provides high-security email, databases of legal information and private conferencing and discussion areas. A City office is only maintained for meeting clients and carrying out certain administrative purposes.

[18] http://davisco.net/bileta.html

As a result of the opportunities for cost reduction which teleworking offers, particularly in terms of office space, Davis & Co.'s overheads (excluding personnel) are 17% of turnover, compared with an industry average of 35%. Moreover, teleworking has increased the number of hours worked by 10% to 15% and productivity by 25%.

Volvo and Ericsson

Öckerö, an island municipality off the west coast of Sweden, has developed a teleworking infrastructure assisted by EU and private-sector funding. Historically, many of Öckerö's residents have commuted to jobs in the Gothenburg area – a two-hour journey, including a ferry crossing. A survey of these commuters indicated considerable interest in teleworking. The municipality has therefore opened a telecentre, partially funded by three major Gothenburg employers – Volvo Data, Volvo Lastvagnar and Ericsson Microwave. The project is regarded as a success by both the teleworkers and the companies involved.

Maricopa County, USA

Since 1988, Maricopa County in Arizona has had a mandatory trip-reduction programme for employers in the authority's boundaries. Initially, this programme included all employers who had over 500 employees at a single work site, but this has since changed to over 50. Approximately 1260 employers, representing nearly 500 000 employees and students, are now a part of the programme.

Employers involved in the programme must submit an annual trip-reduction plan, but can call on the Regional Public Transportation Authority to assist them with this. Acceptable alternatives include not only teleworking but also carpools, vanpools, bus, bicycling, walking and compressed work weeks. As part of its promotional activities, the local authority has written a series of case studies of employers which have introduced telecommuting. Among them is American Express, which has run a teleworking programme since 1992.[19] 150 employees at its service centre in Phoenix telework regularly, and American Express has calculated that if 5% of its total employees worked from home, it could save $25 million in real estate costs over five years.

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19 http://www.valleymetro.maricopa.gov/case3_amex.html

Surrey County Council

In September 1996, Surrey County Council opened its first neighbourhood telecentre for council employees.[20] The centre offers both meeting rooms and individual PC workstations; some resources are bookable in advance, while others are reserved for field workers (peripatetic employees). A report on the first three months of the seven-month trial noted that staff from all departments used the centre, with a mixture of office-based professionals (60%) and peripatetic employees (40%). The majority of office-based professionals use the telecentre as an extension of their main office, while peripatetic employees either use the telecentre as a base for the day while in the area, or as a 'drop-in' facility between meetings.

It also recorded a variety of measures of success.

- There was a high level of repeat visits – 70% of new visitors to the telecentre in September and October used the telecentre again.
- Teleworkers, their colleagues and their line managers professed a high level of satisfaction: productivity was felt to be up to 50% higher, due to the working environment, reduced travelling time and the need for teleworkers to plan their work thoroughly in order to identify the tasks which could best be done at the telecentre.
- While the modal split in the form of transport used by teleworkers did not differ greatly from that for other employees, the average duration of each car journey from home to work for teleworkers fell by approximately 36%. Moreover, they spent over 50% of the time they saved through reduced travel in the telecentre working, again contributing to productivity gains.
- The utilisation rate of resources in the telecentre rose from 28% in September to 52% in November. This compares favourably with an average utilisation rate of less than 50% for a random selection of buildings from the existing Surrey County Council property portfolio.

20 http://www.surreycc.gov.uk/telecentre/evaluation.html

Swedish Ministry of Social Affairs

The need to set an example on teleworking has been taken literally by the Minister of Social Affairs for the Swedish government, Margot Wallstrom. The Minister is responsible for one of the most important Ministries in Sweden (SEK159 billion budget); and she is also, as a parent, responsible for two children. She has therefore decided to become a 'teleminister' using teleworking techniques, including a World Wide Web (WWW) site, to communicate with her colleagues and the public. The Minister works at home on Mondays and Fridays at Karlstad, 300km from Stockholm, with her children and her computer.

Cambridgeshire County Council

A recent report by Cambridge-based consultancy, the Home Office Partnership, throws interesting light on how teleworking might affect traffic movements in Cambridge.[21] The report, which was funded by the Department of the Environment, Transport and the Regions, was based on a study of 2367 Cambridgeshire County Council employees employed at the Council's head office in Cambridge whose jobs make them potential teleworkers. These staff represent approximately one-third of the administrative staff employed by the Council.

The study estimated that the telework potential for the types of employees in the study was 0.25 to 1.5 days a week in the short term and 3 days in the long term. The report also noted that even senior managers felt they could work from home at least one day a week. Scenarios showed that the staff surveyed could reduce their total commuting travel by 800 000km and 40 000 hours in the short term, rising to 2 million km and 70 000 hours. Similarly, in-work travel could be reduced by 300 000 miles in the short term, rising to 900 000 miles.

By applying its results to the City as a whole, the study estimated that commuting travel in the morning and evening peak times could be reduced by 30%.

21 Home Office Partnership (1997).

2.2 TELEGOVERNMENT

Telegovernment is the use of ICT by all branches of government to improve services, increase efficiency and increase accountability to the electorate. It refers to both internally-orientated initiatives (for example, moving to common electronic data storage so that several departments can draw on the same data) and externally-orientated initiatives (for example, allowing electronic completion and submission of tax forms). Telegovernment has already been identified as a key issue by national governments in Europe and beyond: for example, the UK government has launched a number of initiatives which aim to make information and forms available on the WWW, including the Direct Access Government initiative which was launched in November 1997.[22]

The incentives for implementing electronic government are numerous and include:

- recognition that such projects can be used to 'pump prime' developments in other sectors of the economy – the government pays suppliers to develop systems which are then adapted for commercial application
- a perception that government should become more responsive to the electorate and provide a better, more efficient, more timely service to 'customers'
- the need to reduce the cost of administration and minimise fraud.

The benefits on offer are substantial, especially in terms of reducing cost and waste, and in increasing efficiency and access. A study by the Swedish Association of Local Authorities suggested that the Swedish state, municipalities and county councils could save around £2.5 billion a year by purchasing goods and services electronically – the study estimated that the cost of handling a single paper invoice is approximately £30. Similarly, the cost of information exchange within and between departments is reduced when the exchange is electronic, while speed and reliability both increase – as a result, the UK government is expanding its CAB-ENET network to aid communication between ministers and civil servants. Finally, telegovernment facilitates easier access to government staff, services and information by citizens.

However, bureaucracies have a poor record both for appreciating the potential of new technology and implementing and managing computer projects. There is also some resistance from the public to aspects of electronic government, such as inter-linked departmental databases, or personal identity smart cards, which can be portrayed as posing a potential threat to the privacy of individuals – many sceptics equate efficient government with oppressive government.

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22 http://www.open.gov.uk/gdirect

Nevertheless, governments worldwide are pressing ahead with telegovernment initiatives, in areas as diverse as immigration controls, online employment services for the unemployed and the publication of the details of pending legislation.

Immigration controls

At Newark and JFK airports in New York and Toronto airport in Canada, regular travellers can pass through immigration control using a smart card (INSPASS) to carry their passport details. An automatic reader checks the geometry of the traveller's hand against data stored on the smart card to confirm his identity.

Personal identity cards

More than 7 million Spanish citizens carry smart cards that identify them to government. In particular, the card must be presented when claiming unemployment benefit. It is hoped that this will eliminate duplication of data, and reduce administrative costs and fraud.

Online job-hunting

In Australia, a national database of job openings can be accessed through touch-screen kiosks in over 320 job centres. Not only is the job search made quicker for the unemployed and cheaper for government, but the unemployed are able to examine opportunities outside their locality of which they might otherwise remain unaware. Electronic monitoring of job searches also cuts down on fraud because it helps identify benefit claimants who are genuinely looking for work.

Tax submissions

In 1995, 3.9 million Canadians filed their tax returns electronically and 500 000 citizens also paid electronically. This scheme has delivered significant savings in data entry costs, as the details of the tax returns would otherwise have to be typed into the necessary databases at the government's expense.

Although Internet users account for only 2% of the Portuguese population, since November 1997 they have been able to check their personal tax situation over the last five years by connecting to the Internet and accessing the Ministry of Finance's online database. Users can see how much tax they have paid, or how much they still have to pay and when. They can also analyse the breakdowns and calculations made by the Ministry. The Ministry has also been working on a project that will allow users to fill in their VAT returns directly online.

National and local government information

- In the USA, www.thomas.gov keeps citizens abreast of pending legislation in Congress, new government regulations and the other business of government. In the UK, a range of similar services are available at www.open.gov.uk.
- The concept of the 'regional information area' is being pioneered in the UK in the Norfolk and Waveney area.[23] Nine local authorities, the local TEC and Business Links are co-operating to build their WWW sites in a structured manner so that users can move seamlessly between them in search of the information they require. This is far more effective than having to locate the WWW addresses for all the different local authorities that might have the information and then searching each one individually. Moreover, for most users the source of the information is a secondary issue – the important thing is that it is accurate and up-to-date.
- The London Borough of Hackney plans to install over 2000 kiosks to give its citizens easier and more efficient access to information about government services and local schemes. It is also connecting local businesses to the Internet in the hope of providing a boost to the local economy.
- Cambridge MP Anne Campbell has promoted the Internet as a resource for all citizens. Among her achievements is the Opportunity Links programme (which provides an online 'one-stop shop' for information on jobs, training and child-care facilities in Cambridgeshire) and Cambridge Online City (which was started in 1994 in order to provide online access to public services for Cambridge residents).[24]

Trade and investment

The Canadian government has created the Canadian Business Map, which provides easy navigation and searching across Canada's business information resources.[25] Content includes Canadian and international company directories; profiles of, and links to, all provinces, territories and municipalities; details of relevant legislation and regulation; and an R&D section providing information on licensing, technology transfer, research centres and funding sources for science and technology.

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23 http://www.tagish.co.uk/nwia/nwia.html

24 http://www.opportunity-links.org.uk/basic/index.htm; http://www.worldserver.pipex.com/cambridge

25 http://commercecan.ic.gc.ca

2.3 TELELEARNING

Telelearning is the provision of education and training at least partly online, such that the majority of the learning can take place at the pace and convenience of the student, and the locations of the student and the teacher are irrelevant. There are two models for delivery: schools and some universities have an enrolled base of students attending classes and use telelearning to supplement the resources available; other educational institutions, particularly in the tertiary sector, use telelearning as the main information delivery channel, perhaps also offering telephone support or occasional face-to-face tutorial sessions.

Telelearning offers significant benefits to cash-strapped governments, students and businesses looking to expand or update the skills and knowledge of their employees.

- **Governments are struggling to meet increasing demand for education**. Developed world economies are moving away from manufacturing and into service industries, and employment opportunities are correspondingly falling for 'blue-collar' manual workers and increasing for 'white-collar' non-manual work. This is generating increasing demand for education, particularly tertiary education: statistics from the UK Department of Education and Employment show a 70% increase in higher education attendance between 1989 and 1995.[26] Telelearning offers a way by which governments can meet demand without incurring the costs associated with traditional teaching methods, such as building new schools and campuses and maintaining a high student:teacher ratio.
- **The composition of the student body at tertiary level is changing**. In the UK, the proportion of 'mature' students (over 25 years old) is increasing, and one-third of students in higher education now study part-time. Courses with a telelearning component are often a more appropriate form of education for students who are seeking to further their education while still in employment.
- **More employers now realise the benefits of providing or encouraging continuing education for their employees**. In the USA, companies spend about $100 billion a year on education and training[27] – European and Japanese companies spend at least as much. Given the opportunity cost to an employer of a valuable employee interrupting his or her career in order to learn, telelearning is a perfect way to deliver knowledge to the desktop, interleaving learning and work.

However, take-up of telelearning is constrained by the availability and affordability of the necessary infrastructure to institutions and individual students, together with

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26 http://www.open.gov.uk/dfee/highed/change.htm

27 See the discussion of the Adaptive Learning Systems Focused Program run by the Advanced Technology Program of the American National Institute of Science and Technology at http://www.atp.nist.gov/atp/97wp-lt.htm

adequate content and training. Only 6000 of 32 000 UK schools were on the Internet at the beginning of 1997. In contrast, over 65% of US schools were connected to the Internet by 1996 and all but 5% have firm plans to be so by 2000. The UK government is currently pursuing a number of initiatives to improve the situation in terms of both infrastructure and content, including:

- **'NetYear'**: NetYear, launched in the UK in January 1998, is a nationally co-ordinated initiative to develop ICT infrastructure in schools and to encourage teachers to develop their skills in using new technologies.[28] It represents the "biggest public/private partnership in any education system, anywhere in the world" and founder members include Cisco Systems, ICL, Sun Microsystems, UUNET UK and BBC Education.
- **the National Grid for Learning**: launched in February 1998, the Grid plans to offer a forum for teachers to share best practice; online course materials; areas for students to work together, for example enabling English students to work with students on the Continent; and access to school materials from home.[29]

In addition, the UK telecoms regulator, Oftel, is promoting the development of the National Grid for Learning, by ensuring that the regulatory framework removes barriers to its implementation, including affordability. Oftel allows BT to offer discriminatory pricing to schools, based on its calculation of the cost of provision to BT. An Oftel working group has recommended that basic rate ISDN (64kbit/s) is the standard service, but also recognises that for some schools dial-up PSTN access is adequate in the short term, while for other larger establishments high-bandwidth leased lines are necessary.

Telelearning initiatives are underway at both secondary and tertiary levels worldwide, as illustrated by the following examples.

Stanford University Stanford University has used the Stanford Instructional Television Network to provide distance learning in its continuous education programme for the last 30 years, but this is only available within a limited coverage area. The Stanford Online project, launched in 1995, now enables 5000 students worldwide to take Stanford engineering and computer science courses by downloading audio, video, text and graphical material over a variety of communications links, including the Internet.[30]

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28 http://www.ukNetDay.org

29 http://www.open.gov.uk/dfee/grid/index.htm

30 http://stanford-online.stanford.edu

Netherhall School

The Netherhall School in Cambridge has pioneered the concept of schools as the hubs of the electronic community, connecting children, schools and community in a local learning network, and acting as both a consumer and a producer of multimedia interactive products.[31]

One example of its activities as a consumer is its participation in the EU Socrates mailbox project. The school linked its pupils via email with those in neighbouring primary schools in a moderated discussion of issues relevant to the curriculum and gave primary school pupils the opportunity to ask the older students what it was like being at the secondary school. Netherhall also involved parents in the project, inviting them to nominate themselves as 'experts', available to answer questions from the children on subjects varying from religion to mathematics.

Via its WWW pages, Netherhall School provides teaching resources to other schools in a wide range of subjects. The school is now part of two ventures through which it hopes to capitalise on its expertise, Education Online and the Neon Partnership.

The school relies on 2Mbit/s links provided by Cambridge Cable. Part of Netherhall's success has been its ability to forge relationships with local and international companies and with Anglia Polytechnic University.

Harvard Business School

Harvard Business School has put its library of business case studies on to the WWW, and uses the WWW both to supplement classroom-based teaching and to provide a variety of catch-up materials to students returning to study after years at work. It is also using ICT to maintain links with students after they have left: in addition to its offer of a life-long email address which forwards mail into whatever local account the student is using at that time, it is trialling 'life-long learning' projects including electronic 'bulletin boards' and 'chat rooms'.[32]

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31 http://www.netherhall.cambs.sch.uk

32 http://www.hbs.edu

UNITAR, Malaysia In response to huge demand for university places, which could not be met through traditional teaching models, the Malaysian government has launched UNITAR (Universiti Tun Abdul Razak) as part of its MSC programme. The university offers two undergraduate programmes – information technology and business administration – and is available to any Malay-speaker with a PC and Internet connection. (At the end of 1997, Malaysia had close to a million Internet users.)

Michigan Virtual Automotive College An example of an industry-specific programme, the Michigan Virtual Automotive College, has been created by the University of Michigan in collaboration with Detroit's local car plants.[33] The virtual school offers courses in automobile engineering, catering to both white-collar engineers and blue-collar workers. Each course is run by a local university or college, and they are delivered across a variety of media, including personal tutor, satellite broadcasting and the WWW.

Western Governors' University (WGU) Supported by the Governors of 15 western US states, the WGU will take courses originally developed by local universities and, by delivering them at least partly electronically, make them more accessible to residents in remote areas. Furthermore, new technology should make courses more adaptable to the pace of modern business – instead of waiting up to a year for term to start, courses should be available when needed.[34]

ZDNet University ZDNet University specialises in computer courses – the institution was founded by Ziff Davis, publishers of computer magazines.[35] Courses cover most aspects of programming and Web design, start each week and are open to anybody with a computer and $4.95 a month to pay for tuition.

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33 http://www.mvac.org

34 http://www.westgov.org/smart/vu/vu.html

35 http://www.zdu.com

2.4 TELEMEDICINE

Telemedicine is the provision of healthcare and advice to individuals and social groups through the use of ICT. Healthcare is a huge market – on average Europeans see the doctor five times a year, and some 30 million people suffer from disabilities – and the incentives to find less labour-intensive and more effective ways of delivering services are equally substantial:

- healthcare provision accounts for 7% to 10% of EU Member States' GDP
- healthcare expenditure is increasing faster than GDP
- labour costs account for 70% of the costs incurred in providing healthcare.[36]

Moreover, the pressures on health services are set to increase still further: as people live longer, demand for treatment of chronic and degenerative diseases will intensify; costly research will carried out into a widening range of diseases and conditions; and if such research is successful, it will identify treatments which may also be expensive.

In one approach to telemedicine, scarce, expensive medical resources, both human and inanimate, are concentrated in centres of excellence linked by ICT to satellite clinics. This offers a means by which quality of care can be maximised, services can be made available to a widely-dispersed client base without the cost, discomfort and possible risk to health involved in making a physical journey, and duplication of investment can be avoided. Another adopts the 'call-centre' model, whereby health queries are dealt with by trained operators. Callers either have their concerns allayed or are directed to the most appropriate medical resource for further investigation and treatment. This approach prevents callers from making unnecessary trips to hospital or their GP, and allows resources to be focused on the highest-priority cases. Finally, online advice databases targeted to different demographic groups, such as expectant mothers or teenagers, can be used as part of preventative health education measures.

One constraint is the healthcare sector's historical under-investment in ICT. The sector relies on many actors producing, sharing and exchanging information, such as test results, X-rays and other images, and research results. According to research in the USA, up to 40% of hospital costs are related to information management, exchange and storage.[37] However, only 1% of the health sector's budget is spent on ICT compared to 6% to 8% for other, similar sized sectors. Other constraints include a lack of standards for the computer exchange of medical information and concerns about data protection, security and confidentiality – in particular, the development of electronic patient records will raise issues in relation to data protection policies.

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36 http://www.ehto.be

37 http://www.lbl.gov/ICSD/Niles/NilesChap3_5.html#RTFToC2

St Eriks Eye Clinic, Stockholm

Telemedicine is routinely used in hospitals in Southern Sweden. Everything from doctor's letters of introduction, to X-ray images, ultra sound images and other information is exchanged between hospitals, specialist clinics and other medical centres. A leading example of innovative use of ICT is St Eriks eye clinic in Stockholm, Sweden, which is linked to ten other healthcare units through ISDN. The clinic is able to offer remote consultation via videoconferencing, with a specialised camera for examining the patient's eye. Such remote diagnoses have been demonstrated to be as reliable as those arising from face-to-face consultations.

Southmead Hospital, Bristol

In late 1997, Southmead Hospital signed a £2.5 million contract with the computer services and systems integration company, EDS. EDS will develop an electronic patient record system called the Advanced Clinical Information System (ACIS). The ACIS will link the hospital's existing administration systems via a graphical interface. The service will also provide an electronic library and Internet access. The system will be introduced in two stages over nine years. The first phase will involve order systems, electronic prescriptions and patient registration, and will be piloted in the departments of cardiology, general surgery and gastro-intestinal medicine. Doctors will use laptop or notebook computers connected to a wireless network to enter orders and prescriptions. In the second phase, the hospital will introduce electronic patient documentation. This will provide shared patient notes for multi-disciplinary care planning.

Leeds City Council

Leeds City Council is running an online project to help house-bound disabled people live as independently as possible of health and social services support. The project provides an interactive link into the homes of house-bound disabled residents, via the Internet and a PC-based videoconferencing system. Services on offer include:

- a teleshopping facility which will allow people to order goods directly from a supermarket
- access to a care worker
- a chat forum which allows often isolated people to interact
- information on services and events.

The aim is to allow the user to connect to one point which will then give him access to a whole variety of different services. The project is being funded by the EU which is providing £231 000 over two years under its *Equality: Teleservices for All* programme.

NHS Direct

Three pilot schemes to test the concept of 24-hour health service call centres were launched in the UK in March 1998.[38] 'NHS Direct' telephone health advice lines have been set up, enabling callers to consult specially-trained nurses about their health concerns. One of the main objectives of the service is to prevent unnecessary visits to accident and emergency centres.

Hammersmith Hospital, London

Hammersmith Hospital has successfully completed the development of a hospital-wide system for the acquisition, storage and distribution of electronic medical images, such as X-rays and ultrasound scans. This is a major step on the way to replacing all X-ray film with digital images. Stored as digital images, the scans and X-rays are more easily available and can be viewed by staff on more than one site simultaneously, in order to aid expert consultations.

National Health Service, Greece

The National Health Service in Greece has announced its intention to reorganise its hospitals and healthcare centres so that all doctors have access to online diagnostic, therapy and teaching resources.[39] Access will be via a nationwide medical network, the 'Medical Information Environment'. The resources will also be available to mobile medical units by way of cellular radio communication services.

2.5 ECOMMERCE

Ecommerce is the use of the Internet to conduct business. This definition includes a wide range of activities, from teleshopping by consumers to financial transactions such as telebanking and share trading. The value of the global ecommerce market has been forecast to rise dramatically in both the consumer and business-to-business markets, as illustrated in Table 2.1.

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38 http://www.coi.gov.uk/coi/depts/GDH/coi9395d.ok

39 http://www.icbl.hw.ac.uk/telep/telework/ttrfolder/typfolder/greek.html

Table 2.1/ Estimates of the Growth of Internet Commerce [Source: company reports; www.cyberatlas.com].

	Consumer markets		*Business-to-business markets*	
	1996 (millions)	*2000 (billions)*	*1996 (millions)*	*2000 (billions)*
Forrester Research	$530	$7	$600	$66
Yankee Group	$730	$10	$12	$134
International Data	$140	$32	$210	$63
Cowles/SIMBA	$733	$4	–	–

Both user groups will benefit from the increased convenience which ecommerce offers. For businesses, this will translate into financial savings, achieved by, for example:

- **electronic invoicing**: handling a paper invoice costs over $150 at many companies, and big businesses handle tens or hundreds of thousands of invoices a month
- **store and warehousing overheads**: as customers carry out more of their shopping online, and retailers move further towards ordering stock on demand from distributors, so companies can reduce the store space and warehouse space they use.

Convenience to the consumer will be in terms of reductions in the number of shopping trips he makes, and the amount of time he spends shopping. Consumers will also be able to make more informed product and price comparisons between retailers which could be widely geographically dispersed. A study carried out for the Consumer Direct Co-operative, a consortium of 31 companies including leading brands such as Coca-Cola and Nabisco, concluded that the number of US households using online services regularly to buy groceries and other goods will increase from 200 000 in 1997 to up to 20 million by 2007, with a value of $85 billion (£52 billion). The same survey predicted that online services will replace at least 8 of the US citizen's average 17 monthly shopping trips made to grocery stores by 2007. The home entertainment and travel agency sectors are also vulnerable: over 80% of the businesses interviewed in a recent study of these sectors found that they expected online sales to overtake traditional sales in less than two years.

Constraints on the growth of business-to-business transactions mainly relate to national boundaries and customs regulations. Although the Internet and satellite TV make it much easier to do business with companies regardless of their physical location, there remain the obstacles of customs clearance, import and export payments, and delivery delays caused by bureaucracy. Concerns about the security of online financial transactions have also been a constraint, but will increasingly be allayed by the availability of payment systems based on 'public-key encryption' technology.[40]

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[40] Browning, J., Hopkins, M. and Thompson, B. (1998).

Teleshopping is unlikely to substitute for conventional shopping completely: dealing with a human salesman and being able to 'touch and feel' products are sometimes key to the purchasing decision, especially for high-value goods such as cars. However, it is in precisely these cases that purchasers will want to make sure that they have made the right decision and the Internet will become established as an invaluable information source. This trend will be increased by the availability of electronic 'shopping assistants' such as Netbot Jango, which search through WWW-shopping sites to find bargains.[41]

As the following examples illustrate, organisations in all sectors and of all sizes are becoming involved in ecommerce.

Amazon.com

Amazon.com claims to be the world's largest bookstore.[42] It sells only over the WWW and therefore carries no inventory, but orders books from distributors on demand. The result is an apparent stock of over 2.5 million titles, most ready for delivery in two to three days. Amazon.com had sales of $148 million in 1997, up 838% from 1996. Its success is based on two key competitive advantages:

- it can offer customers unprecedented depth of choice
- it builds up a direct relationship with its customers, helping them decide what purchasing decisions to make by providing editorial content, or by using software which recommends further purchases on the basis of products in which they have already displayed an interest.

PKO, Finland

The Pohjois-Karjalan Osuuskauppa (Northern Carelian Co-operative Shop) in Joensuu, Finland, has opened a supermarket on the Internet. Users (currently limited to members of PKO) can select from a list of 2000 items. Home delivery is guaranteed in three hours. Each customer has an account with PKO – bills are currently sent direct to the customer, but soon the invoice will go directly to the customer's bank account and be directly debited. In order to encourage take-up, the Joensuu city authority offers its employees free access to the PKO service; this allows just-in-time delivery of orders, for example just before the end of the working day.[43]

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41 http://www.jango.com

42 http://www.amazon.com

43 http://kauppa.carelian.fi

Fastway

Fastway, a touch-screen service recently launched in Australian shopping malls, is claimed by its makers to be the world's first multi-function electronic commerce system. Companies such as American Express, New Zealand Insurance and Macquarie Bank offer products and services via the system, with users able to talk directly to the company representatives via an on-screen video link and the attached telephone handset. Printouts of items such as a pre-approval for a mortgage are available.

In the short term, new services to be added will include the facility to pay utility bills direct from credit cards, smart cards or bank accounts; search for jobs through an appointments noticeboard; and purchase cars. Longer-term plans for the system include a link with the Australian Stock Exchange to allow users to trade shares.

MSFDC

MSFDC is a joint venture between Microsoft and First Data Corp, one of the world's largest processors of credit-card sales and other existing electronic transactions.[44] During 1998, MSFDC will launch an 'enhanced bill-paying service' aimed at replacing some of the 1.25 billion or so cheques that Americans write each month to pay bills.

The bill-paying service will be free to consumers. Their bills will be distributed to their PCs over the WWW, using 'push' technology. Payments are then made direct to the supplier, electronically, at first using a password and personal identification number, but eventually with a smart card and/or digital signature.

The companies using the service pay for it. MSFDC says each transaction will cost approximately the same as the postage which would have been used to send the bill and its pre-paid response – leaving companies free to pocket the savings of not handling the documentation. Moreover, the push technology used to distribute bills gives the companies a valuable interactive communications channel that can be used to improve customer relationships.

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44 http://www.msfdc.com

Worldpay Worldpay, a secure electronic payment system which claims to be the first system in the world to support multiple currency and payment options for online retailers, was launched in October 1997. The service, which was developed by National Westminster Bank and Supernet, a Jersey-based Internet service provider, allows Internet retailers to offer users the ability to purchase products and service in over 100 currencies and to be paid in up to 16: users select the currency in which they wish to pay. It also supports the management of loyalty programmes, to encourage repeat business from customers. Among the first users of the Worldpay technology are the Internet service provider, PSInet, and The Sporting Life magazine.[45]

Apple Computers Apple Computer's on-line Apple Store opened in November 1997.[46] It received over 4.4 million 'hits' and took over $500 000 of orders during its first 12 hours of operation. The Apple Store is part of the company's new distribution strategy of combining direct sales over the Internet alongside retail outlets. Apple's new G3 computers can be built to order to match exact specifications input by customers ordering online.

2.6 SMART CARDS

Smart cards contain information relevant to a particular person or application, stored on microchips. They are used primarily as security or identity cards, often combined with the ability to make payments electronically. 1.1 billion smart cards were in use around the world in 1997 and this is forecast to grow to 2.3 billion by 2000.[47]

Smart cards are one area in which Europe leads the USA, primarily because magnetic strip technology, which is an older, less powerful solution, is more entrenched in the USA. The European market is worth $1 billion, with much of the growth in pre-payment schemes, pay-per-view TV, mobile phones and fare collection. Smart cards have been used in several trials as an alternative to cash payments for goods. Cards are loaded with credits and then used either to purchase a specific service (e.g. use of public transport) or for general retail purchases in the same way as a conventional debit card. Smart cards are also rapidly being adopted by companies in particular sectors, such as

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45 http://www.worldpay.com/pressreleases

46 http://store.apple.com

47 http://www.verifone.com/corporate_info/press_rel/html/pr090397_advisory_service.html

the travel industry where cards can be programmed to store information such as users' preferences for hotel rooms or aeroplane seating, as well as providing the ability to check in or pay bills electronically.

Smart cards are welcomed by businesses, because they reduce the need to keep cash on the premises and offer the potential for lower banking charges. They reduce the need for monthly printing and postage of bills or balance statements by issuing these on an *ad hoc* basis when the card is used, or by enabling customers to check their balance by accessing their account online. They also enable the development of closely-targeted loyalty programmes and promotions using the information gathered on the card. The prime attraction of smart cards to end users is the ability to make even small denomination purchases without having to carry cash around. Constraints on the take-up of smart cards relate mainly to retailers' reluctance to invest in the necessary hardware when it is still not clear which of the competing schemes will become the *de facto* standards. There are also residual concerns about the security of making payments over the Internet.

Examples of the most popular types of smart card applications are provided below.

Mondex

With Mondex, cash resides on a smart card 'electronic purse', which is capable of holding multiple currencies.[48] Low-cost readers enable these cards to be plugged into PCs or telephones for home shopping or for recharging with cash from a bank. Trials have been undertaken in Swindon since 1995, and more recently in Hong Kong, San Francisco and New York.

The trial in the Upper West Side area of Manhattan began in October 1997 and is the largest smart card pilot in the USA to date, involving Chase Manhattan Bank and Citibank. The area is densely populated and Chase Manhattan has issued 45 000 existing debit- or credit-card holders in the area with a new card which integrates both Mondex and the existing functions. 39 Chase Manhattan cash machines in the target area have been converted to download Mondex cash as well as distribute physical notes.

The initial target was for 650 retailer sites to be operational within the first month of the pilot and Mondex's suitability for low-value payments is attracting interest from traditionally cash-orientated

[48] http://www.mondex.com

retailers, such as dry cleaners, news stands and fast-food chains. One objective of the trial is to test the interoperability of Mondex with other electronic payment systems using the emerging Europay/MasterCard/Visa standard for point-of-sale terminals and equipment.

Hertfordshire County Council

The 'Herts Smart' scheme was launched in December 1997 by Hertfordshire County Council, which is initially providing smart cards to local school children and pensioners for use on public transport in the county. It anticipates that 30 000 smart cards will be in use by the end of 1998. The council currently spends £9.5 million on travel concessions each year and it predicts that this scheme will pay for itself within three years by reducing administration costs and enabling the council to pay the operators on the basis of accurate information. It is also encouraging local companies to join the scheme and issue cards to their employees to provide them with discounts on buses in a bid to promote a move towards greater use of public transport.

Leicester Environmental Road Tolling Scheme

The Leicester Environmental Road Tolling Scheme, which began in August 1997, is investigating what level of road pricing will be required to persuade drivers to use alternative means of transport to get into the city centre. Drivers are notified of daily toll levels via coded messages transmitted to their on-board computers – the charge will depend on daily pollution and congestion levels. They can then choose to either:

- insert a smart card into an in-car computer which deducts the toll charge from the card
- take a park-and-ride bus service into the city centre instead of paying road tolls.

The scheme is a collaboration between Leicester County and City Councils and the Department of the Environment, Transport and the Regions.

AOM

The French airline, AOM, launched the world's first smart card based frequent flyer programme in May 1997.[49] When customers check in at AOM desks, their card is instantly credited with points, depending on the destination and type of seat required. AOM is extending the scheme to include partners such as car rental companies, hotels and restaurants. Points stored can be exchanged for rewards, such as free flights or instant upgrades, at any time and at any terminal belonging to AOM or a partner.

The terminal prints a detailed loyalty statement after each transaction, showing the status of the cardholder's account (prior balance, points earned with this transaction and new balance) and promotional material from AOM and its partners. In the future, the multifunction smart cards will be enhanced to allow for electronic ticketing capabilities.

2.7 WIRED CITIES

'Wired', 'smart' or 'intelligent' cities or regions have moved beyond applying ICT to meet specific, but isolated, requirements. Instead, they have developed a vision which places ICT at the centre of their plans for future development, and places themselves as leaders in the global information society. While this vision is broadly common to all the cities discussed in this section, they have adopted a range of approaches to achieving it:

- launching central government investment initiatives in ICT projects which are deemed to be nationally important
- setting up an independent company to provide infrastructure, thus encouraging new entrants to provide advanced services without each having to incur the costs of deploying its own network
- awarding an infrastructure franchise to an additional operator, thus increasing the level of competition and improving the quality and range of services available to customers
- encouraging an operator to use the region to trial advanced infrastructure and services
- forming a partnership between public and private stakeholders to drive forward ICT initiatives.

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[49] http://www.slb.com/ir/news/et-aom0997.html

2.7.1 Use central government investment

Multimedia Super Corridor, Malaysia

The MSC project was announced by Malaysian Prime Minister, Dr Mahathir Mohammad, in May 1997.[50] Due to be up and running during 1998, the MSC is a 15km by 50km zone extending south from Malaysia's capital, Kuala Lumpur, to the new Kuala Lumpur International Airport. It will have leading-edge ICT and physical infrastructure and a comprehensive package of incentives and support for companies. The nucleus will be Malaysia's future capital city, Putrajaya, and the new IT city, Cyberjaya.

The MSC offers a high-capacity global telecoms infrastructure built on a 2.5Gbit/s to 10Gbit/s digital optical fibre backbone. Special time- or distance-independent tariff structures will be developed for MSC companies.

Flagship projects in two categories will be launched in 1998:

- the first category focuses on developing applications in electronic government, telemedicine and smart schools, plus the launch of a national multi-purpose smart card
- the second focuses on creating the best environment for companies that locate in the MSC. Projects include 'world wide manufacturing webs', borderless marketing centres, and R&D clusters.

IT2000, Singapore

Launched in 1992, the IT2000 project provides a framework to guide ICT development in Singapore into the 21st century.[51] It will transform Singapore into an 'intelligent island', where IT is pervasive in every aspect of society: at work, home and play. Singapore ONE is a strategic initiative under IT2000 which will be the channel for delivering the next generation of applications and services envisioned under the IT2000 masterplan by:

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50 http://www.mdc.com.my

51 http://www.ncb.gov.sg/ncb/it2000.asp

- building a National Information Infrastructure, a high-capacity backbone network that will reach businesses, schools and homes throughout the nation
- deploying flagship applications.

Business partners will play a vital role in introducing advanced technologies and providing innovative applications and services. This is intended to help to make Singapore a hub for the research and development, marketing and use of advanced technologies such as interactive multimedia.

The pilot service was launched in the first quarter of 1998 and full commercial availability is planned for December 1998.

2.7.2 Set up an independent infrastructure company

Stockholm, Sweden

In 1993, the City of Stockholm decided to make the ducting and other existing resources within its utility companies and agencies available to other organisations, in order to help build a high-speed (2.4Gbit/s) telecoms infrastructure to compete with that of the incumbent operator. The company which it formed to do this, Stokab, now provides access to ducting and fibre optic cable within the Greater Stockholm area. Other operators rent fibre from Stokab and then 'construct' networks and services to reach their target customer base.

The Stokab network links the down-town area, suburban centres and business parks. Over 1996–7, schools were provided with fibre connections, and thus the ability to receive high-bandwidth Internet access. The next main task is to connect all hospitals in the Greater Stockholm area.

2.7.3 Award a franchise to another infrastructure operator

Austin, Texas

Believing that its existing telecoms operators were not moving fast enough to meet its goals, Austin decided to award a network infrastructure franchise to a third player through a competitive tender.[52] The rationale was that Austin could either take steps to

52 http://162.89.0.17/finance/rfsprptw.htm

"encourage change proactively to bring the best of new technology to as many of our citizens as rapidly as possible, or wait until the incumbent service providers decide to serve the Austin market with an open broadband infrastructure." It chose the former.

After consideration of the bids submitted in March 1996, the City Council opened negotiations with CSW Communications, Inc. (CSWC) to provide a city-wide open broadband network that will accommodate competitive telecoms, data and video services including education, high-speed Internet access, telecommuting, healthcare, entertainment and ecommerce.

The agreement laid down that the network be financed, owned and operated by CSWC, while the City Council would allow use of its rights-of-way in a competitively neutral manner (as it does with the existing providers). CSW has completed building the network in the down-town area and is now beginning to build it out into the residential areas.

2.7.4 Encourage an operator to use the region as a testbed

Ennis, Republic of Ireland

In 1997, Telecom Eireann, the incumbent telecoms operator in Ireland, invited towns to compete to become its 'information age town', acting as a test bed for a raft of technologies and applications.[53] The winning town, Ennis, in County Clare, has subsequently received £15 million investment by Telecom Eireann in advanced technology including:

- a telephone with digital voicemail in every home
- an ISDN connection for every business
- PCs linked to the Internet for the majority of homes
- access to public service online
- smart card technology.

Once the underlying infrastructure is in place, Telecom Eireann will gauge user responses to ascertain which services are likely to generate most demand and assess the commercial viability of rolling out the service on a countrywide basis.

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53 http://www.irish.times.com, http://www.telecom.ie/presrel

Furthermore, Bank of Ireland, AIB Bank and Telecom Eireann have chosen Ennis as the location for a smart card based 'ecash' scheme. From September 1998, Ennis residents will be issued with smart cards which will enable them to pay for public telephone calls, newspapers, car parking and a range of other small value purchases electronically. Cards can be reloaded via self-service machines installed by the banks in public places, Telecom Eireann payphones, and terminals in customers' homes.

Kohoku, Japan

In July 1997, NTT Data began a two year trial of a 'Virtual N-Town' in Kohoku New Town, Japan.[54] The trial which began with 1000 households and will be extended to 3500 people, is the biggest cable TV network trial ever done in Japan.

The Virtual N-Town aims to provide all the services available in a real town. Residents can book public facilities such as local tennis courts and visit 50 local shops. Products can be bought online using a smart card, and delivered to the home. Customers are also able to see and converse with the sales staff in the shops and with other inhabitants of the town.

The project is unusual in that it uses a TV and remote control instead of a PC, in order to ensure the widest possible use by all ages of residents. All residents have been provided with a smart card and reader at home in order to identify themselves as part of the community when they wish to visit the Virtual N-Town.

2.7.5 Form a public/private partnership

Eindhoven, the Netherlands

The Regio Eindhoven Digitaal (RED) project traces its origins to 1994 and the publication of the European Commission's report on Europe and the global information society.[55] RED's mission is to "start a movement through which the region of Eindhoven obtains international celebrity as a first class location for multimedia industry." It plans to achieve this by developing a wide range of online information, commerce and entertainment services in the Eindhoven region as quickly as possible.

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54 http://www.nttdata.jp/products_services/professional/public/ps/vnt/english.html

55 http://www.red.nl/alge.html; European Commission (1994).

An agreement has been signed with infrastructure providers to develop a high-performance information infrastructure in the region: participants include PTT Telecom (the incumbent Dutch telecoms operator), PNEM (Noord-Brabant Energy Society, owner of cable networks) and KTE (Cable Television Eindhoven). Other initiatives include:

- the Multimedia Science & Businesspark Eindhoven, which opened in December 1995 and provides facilities for both small and large multimedia companies
- a multimedia educational institute to train workers in the required skills.

The Board of the RED project consists of representatives from companies, educational institutes and government agencies in the Eindhoven Region.

As these examples indicate, several approaches are possible to building the infrastructure required to become a wired city. However, before a decision can be taken as to the most appropriate approach, cities which aspire to be wired have to overcome the difficulties of finding out what alternatives are available and which policies, applications and technical solutions have proved successful elsewhere. In recognition of these and other issues, members of projects in six leading wired cities – Singapore, Eindhoven, Kansai, Orlando, Silicon Valley, and Stockholm– decided to form the Advanced Networked Cities and Regions Association (ANCARA) in 1996.[56] The founding members, and subsequent participants such as the MSC and the city of Columbus, Ohio, use ANCARA as a means of:

- exchanging ideas and experiences
- educating the public and government about the importance of support for advanced infrastructure projects
- encouraging the private sector to participate in such projects.

ANCARA and other such initiatives demonstrate clearly that many cities and regions worldwide are implementing the necessary conditions allow them to take a leading role in the global economy of the next century. Planners, policy makers and the high-tech community in Cambridge and the rest of the Eastern Region should consider carefully what steps they need to take to be able to compete as effectively. The following chapter makes a number of recommendations to that end.

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[56] http://www.ancara.nl

3/ The Opportunity

It is the contention of this report that ICT can be an important tool for policy makers and planners, assisting them in their dual objectives of managing growth throughout the Eastern Region *and* preserving and improving the environment in Cambridge and the surrounding area. Moreover, these objectives can be achieved by harnessing the expertise in ICT which already exists in the region.

On the basis of our research, we present for consideration by policy makers four sets of recommendations for the future development of the region, relating to:

- **ICT infrastructure**: communications networks that link people and organisations to one another
- **social infrastructure**: teleservices that can be supplied over these networks, for example telelearning and telemedicine
- **physical infrastructure**: roads, railways and air links and their usage
- **entrepreneurial culture**: the attitudes and policies of decision makers in the region towards business and innovation and the services needed to support them.

Each of these sets of recommendations is closely interconnected with the others, and it is our intention that they should be implemented as a whole. We have sought to identify the players likely to be involved in the implementation of each recommendation, categorising the nature of their involvement as follows:

- **direct action**: the player has the power to act alone to implement the guideline
- **indirect action**: the player can influence others to implement the guideline by, for example, providing funding or making the planning environment more favourable
- **education**: the player can publicise successful examples of relevant projects, or fund surveys showing the benefits of implementing a guideline.

In several cases, we have identified a local government authority or a branch of central government as the player responsible for implementing the recommendation. This is not to say that commercial companies and market forces are irrelevant to achieving the goals

of this report, but rather reflects the fact that government has two key roles to play: it can remove obstacles so that market mechanisms can function more efficiently; and it can act as a catalyst, providing the impetus needed to get from pilot project to full-scale service. Central government is well placed to perform both these roles; local government is in a good position to perform the second, provided it has the political will to do so.

In drawing together this set of recommendations, it is apparent that several aspects of the topic deserve further work.

- We have not dealt with all of the potential applications of ICT. For example, ICT could make a major contribution in the areas of security and policing. Falling prices of video cameras and bandwidth mean that closed circuit TV (CCTV) surveillance, which has been employed in the centre of Cambridge to great effect, could become more widespread in the future as the costs come down.
- We have not discussed in depth some of the social or legal issues arising from the use of ICT, for example concerns about the threat to individuals' privacy as a result of increasing use of CCTV or smart cards, or concerns about the degree of security of information transferred over ICT infrastructure, for example, during a remote consultation between a consultant and a patient in a telemedicine application.

These issues are clearly of great relevance to discussions of ICT implementations, but are beyond the scope of this report, which should be viewed as a starting point. If its recommendations meet with approval and support, then all of these issues can be given the consideration they deserve.

3.1 ICT INFRASTRUCTURE

The ICT infrastructure referred to in this section includes both fixed networks (where signals are transmitted via copper wire and fibre optic cables) and wireless networks (which transmit communications signals via radio frequencies). Existing infrastructure providers in the region are outlined below.

Fixed national networks

Cambridgeshire, and indeed the whole of the Eastern Region, is served by four fixed national networks, operated by BT, CWC, Energis and Ionica.[57] The telecoms services offered by these companies range from basic voice telephony for residential users to leading-edge high-bandwidth services for large companies, provided via a mixture of copper, fibre and wireless technologies.

[57] http://www.bt.com; http://www.cwplc.com; http://www.energis.co.uk; http://www.ionica.co.uk

Fixed regional networks

The region is also served by a number of networks deployed by telecoms operators or other organisations with a restricted geographical focus and coverage:

- the **Cambridge Cable Group** spans four franchise areas (Cambridge Cable, Anglia Cable, East Coast Cable and Southern East Anglia Cable) which cover approximately 500 000 homes and 33 000 businesses.[58] It has built a fibre optic network capable of supporting a wide range of telecoms and entertainment services, including ISDN and leased circuits at speeds up to 140Mbit/s.
- **Eastern Group Telecom** (EGT) is a subsidiary of Eastern Electricity. While the company was awarded a licence to offer telecoms services on a national basis in July 1996, the bulk of its 1800km network is still in the Eastern Region. The core network operates at speeds of up to 2.4Gbit/s, and services are primarily targeted at large businesses.
- **The Granta Network** provides an advanced communications infrastructure for the University of Cambridge, linking 80 sites including the colleges, Addenbrooke's Hospital and the Cambridge campus of Anglia Polytechnic University through 56km of optical fibre.

Wireless networks

In the Eastern Region, 'mobile' networks are provided by Cellnet, One 2 One, Orange and Vodafone, the national UK mobile phone companies operating in the UK.[59]

On this basis, Cambridgeshire is already well served by infrastructure installed by several competing network providers: in the UK, only the City of London has more competition in communications provision. However, despite the number of competitors, most of the bandwidth available is relatively low speed and the cost of using advanced high-bandwidth applications, such as videoconferencing and image transmission, is a deterrent. Operators are reluctant to invest in further major infrastructure upgrades, or adopt pricing structures that would make high-speed bandwidth affordable to the vast majority of users, while they are unable to identify a 'killer application'.

Thus, a key task in promoting ICT as a solution to the region's problems is to first overcome the operators' reluctance to invest. Government has a crucial role to play in this respect, because it has the ability to catalyse developments in several areas of

58 http://www.camcable.co.uk/home.html

59 http://www.cellnet.co.uk; http://www.one2one.co.uk; http://www.orange.co.uk/orange; http://www.vodafone.co.uk

economic and social activity. While it would be hard to convince a network operator that it should cut tariffs on high-bandwidth services purely in order to enable schools to use them, the business case looks much healthier if demand is forecast from a wide variety of sources, such as the NHS (for telemedicine applications), local government (for teleworking) and local businesses (for videoconferencing). Thus, our first recommendation places government right at the heart of the ICT revolution.

Recommendation 1: The RDA should take the lead on the application of ICT within the Eastern Region, making the availability of affordable high-speed ICT infrastructure a strategic priority.

Charging the RDA with responsibility for ensuring the availability of affordable high-speed communications for business and residential users in Cambridge and the Eastern Region is the key recommendation in this report. Without affordable high-speed bandwidth, the substitution effects of ICT cannot take place and the impact of all the other guidelines will be reduced. While the RDA is not a telecoms regulator or operator, it can make a significant contribution to the development of the region's ICT infrastructure by:

- emphasising its importance in terms of a tool for improving regional competitiveness
- promoting the environmental benefits of using ICT.

We therefore suggest that one of the RDA's first actions should be to appoint an ICT working party which acts as a focal point for policy-making in this area. In addition, there are three main ways in which the RDA could implement this guideline:

Include ICT in the regional planning guidelines

By forcing changes in the Regional Planning Guidelines to ensure that provision is made for ICT infrastructure in the construction or redevelopment of offices, factories and homes, it would be possible for city and county councils and unitary authorities to create planning and building regulations which require:

- provision of adequate ducting into and within all new commercial premises for communications infrastructure
- building designs which avoid the creation of large areas of 'shadow' so that radio signals cannot be received in all parts of the building
- the construction of ICT-ready homes.

Planning regulations should also insist on shared use of infrastructure (ducting and radio masts) in order to minimise the environmental impact of further infrastructure deployment.

Promote the Eastern Region as a location for deploying advanced infrastructure

The RDA should promote the region to operators and Oftel, as the best place in which to run their trials of new services. For example, it could seek to ensure that the Eastern Region became the site for trials of new high-bandwidth radio services. Where appropriate, it could work with operators and equipment suppliers to identify sources of funding for advanced infrastructure projects from bodies such as the EU and the European Investment Fund.

Generate awareness of the benefits offered by ICT, including the commercial returns

The RDA can help to generate awareness within the region of the applications of advanced ICT infrastructure and of potential market opportunities by publishing the results of pilot studies and surveys. These would demonstrate the benefits to users in terms of efficiency and cost savings, while emphasising to network operators and service providers, the viability of the business case for advanced infrastructure investments.

Furthermore, we suggest that the RDA place special emphasis on measures to assist residential users and small to medium-sized enterprises (SMEs). In order to build an information society in the Eastern Region, these will need access to 8Mbit/s links to their premises and homes, compared to typical maximum rates of 128kbit/s at present:

- 8Mbit/s access links would allow residential users to exploit services such as videotelephony, video on demand and high-speed Internet access to facilitate teleworking. They would also enable simultaneous high-quality access to a range of services, with members of the family able to make phone calls, browse the WWW and order the week's shopping online.
- SMEs make a crucial contribution to the regional, national and European economy, but evidence suggests that they lag behind larger businesses in their use of ICT: "Though Europe's 12 million SMEs are rightly regarded as the backbone of the European economy, they do need to manage both information and managerial resources better."[60] Affordable bandwidth on the scale noted above would allow businesses to take advantage of services such as videoconferencing, high-speed Internet access, and image and document transfer.

Larger businesses and institutions are less in need of attention, as higher bandwidth is already available to them in the form of leased lines, and they are in a strong position to negotiate the level of service they require at a reasonable price.

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60 European Commission (1994): 'Europe's Way to the Information Society: an Action Plan', COM(94)347 final (Brussels, 19 July 1994).

3.2 SOCIAL INFRASTRUCTURE

In this section, we discuss the ways in which the ICT infrastructure described above can be used to improve the 'social infrastructure' and quality of life for residents, employees and businesses in the Eastern Region, by facilitating the deployment of imaginative teleservices in four key areas:

- teleworking
- telegovernment
- telelearning
- telemedicine.

3.2.1 Teleworking

As the examples in Chapter 2 show, local government is an ideal candidate to demonstrate the benefits of teleworking, prompting our next recommendation.

Recommendation 2: Local government takes the lead on teleworking by setting up projects which will demonstrate to local businesses its benefits in terms of fewer vehicle miles travelled, increased productivity of employees, savings on office costs and (to a lesser extent) reduced air pollution.

Another benefit associated with increased take-up of teleworking is particularly relevant to Cambridge's ability to absorb further growth. As discussed in Chapter 2, most studies report that teleworking has a beneficial impact on the number of car journeys made in the peak hour, thus spreading the times at which roads are under the greatest pressure.

Local government has particular credibility in promoting teleworking, as it is a major employer in the local economy and its employees perform a wide range of jobs with different levels of requirement for office-based, home or remote working. This should help to overcome one commonly cited obstacle to the widespread take-up of teleworking, that it is only suitable for employees undertaking a very narrow range of tasks.

3.2.2 Telegovernment

As discussed in Chapter 2, electronic government has already been identified as a key issue for by national governments in Europe and beyond. There are clearly numerous fronts on which local government could move forward with telegovernment, but our recommendation focuses on one initiative which will help to meet a number of objectives.

Recommendation 3: Local authorities across the Eastern Region should co-operate to build an online 'regional information area', in order to improve communications between local authorities, provide transparent access to resources and support the identity of the Region.

The benefit to policy makers and planners in the Eastern Region of introducing a regional information area, similar to that being constructed for the Norfolk and Waveney area, as described in Chapter 2, stems primarily from the opportunity to improve communications between local authorities. By sharing information across local authority boundaries, employees and community representatives could benefit from the lessons learned by their peers, saving money or reducing duplication of effort as a result. The information area would also offer the opportunity to present the Region as a single entity, both to its residents and to those from outside the region who may wish to either visit it or invest in it. In particular, it could be used to position Cambridge and the Eastern Region as a focus for high-tech companies.

3.2.3 Telelearning

The key objective for the implementation of telelearning through the region is to promote 'life-long learning'. This concept is already well understood by the region's policy makers and planners, and reflects the need for employees to continually update their skills in a world of rapid technological evolution. This will be achieved by encouraging the education and training sector to co-operate with local businesses and other sectors of the local economy, to produce people with the right technical and entrepreneurial skills to support the continued growth of the region, as reflected in our next recommendation.

Recommendation 4: Local government should promote the development of telelearning by using this method to meet its own employees' 'life-long learning' needs. Schools and further education institutions should start providing telelearning options as part of their mission to meet the Region's training and education requirements.

By requiring further education institutions to provide telelearning courses for government staff, and encouraging trials of telelearning in schools and for other sectors of the local economy, local authorities can help telecoms operators to understand the amount of capacity required to support telelearning applications across the region and to test whether the current plans to provide basic-rate ISDN services to schools will be adequate to meet the demand.

The high-tech sector has a particularly important role to play in the promotion of telelearning. Companies in the sector are uniquely well placed to pioneer its adoption, given their understanding of the potential of new technology and their need for continuous training to keep their employees informed about leading-edge developments in ICT. Schools and further education institutions should therefore target the high-tech sector as an immediate priority, working with companies to develop the kinds of learning materials which their employees require. Not only will this provide an additional revenue stream, but education providers can also use this collaborative relationship to educate and inform ICT companies about the specific networking and technology requirements of the education marketplace.

3.2.4 Telemedicine

As shown in Chapter 2, trials of remote consultation and diagnosis have proved successful in clinically and in terms of time saving, and appear to have been acceptable to patients. This body of experience forms the basis of our next recommendation.

Recommendation 5: NHS Trust hospitals and GPs in the Eastern Region should pilot remote consultation and diagnosis, facilitated by ICT.

Telemedicine covers a wide range of possible applications, but we recommend that the NHS in the Eastern Region should concentrate on building a communications network to link its hospitals, GP surgeries and community health centres to support remote consultation and diagnosis. Even with advances in compression technology, such a network would require large amounts of bandwidth (in the region of 2Mbit/s to 8Mbit/s for transmission of high-quality images) but, once this network was in place, scope for building other services upon it could also be exploited. A direct by-product of implementing remote consultation and diagnosis would be a reduction in the amount of traffic around major hospitals such as Addenbrooke's, which is a well-known source of congestion in Cambridge.

In order to fund these trials, deliverers of healthcare may need to go into partnership with companies which supply the sector, such as pharmaceutical companies, IT and telecoms companies and medical insurance companies. Information on completed trials should be published and disseminated by the trial participants in order to show the benefits of using telemedicine. The Region's health services should seek to establish a track record for innovative and efficient use of ICT. They could then use their reputation to obtain funds to try new approaches to health prevention and the delivery of healthcare.

3.3 PHYSICAL INFRASTRUCTURE

In this report, the term 'physical infrastructure' encompasses the roads, railways and flight paths that we use to travel from one place to another, together with the means of getting there – bus, train, aeroplane, private car, bicycle or on foot. ICT does not remove the need for physical infrastructure but it can both *supplement* physical infrastructure, by increasing the efficiency with which it is used, and *substitute* for some physical infrastructure, enabling people to work together even when they are physically separated. Our next recommendation covers both of these aspects.

Recommendation 6: Local government and other relevant bodies should use ICT to improve the efficiency of transport systems and traffic management within the region. This should be complemented by:

- provision within the new Regional Planning Guidelines for upgrading the Region's main road, rail and air links
- a strengthened commitment on the part of local government to keeping the car out of urban centres and to providing attractive alternatives for public transport users, cyclists and pedestrians.

In terms of ICT-based initiatives, local government has a wide range of options available, including in-car traffic information and guidance services, and intelligent road traffic management systems which can respond in real time to actual traffic conditions. The most controversial would be to introduce road pricing as a way of controlling peak-time traffic on routes into cities such as Cambridge. Wireless communications technologies could broadcast signals to terminals in cars, informing the driver of the cost of entering the city, which would vary according to the degree of congestion and pollution on the day. Smart card readers in cars would automatically deduct the cost if the driver decided to continue into the city rather than diverting to a local park-and-ride site.

Alongside such deterrents, Cambridge and other towns and cities in the Eastern Region, will have to provide incentives for people to stop using their cars, by ensuring that there are adequate alternatives available. For most people, this will mean buses or taxis. Funds from a road-pricing scheme, or from a workplace car-parking tax, could be used to support extended bus or rail services, again supported by ICT. The most useful thing that policy makers and planners could do is to ensure that, having left one's car at a park-and-ride site, it is simple to return to it: affordable 24-hour transport will be a necessity. However, it will also be a considerable incentive if more reliable and accurate information was available to reduce the waiting and uncertainty involved in using public transport, and to ease the problems involved in planning journeys using more than one operator. For bus and rail passengers, improvements could include route-

planning and real-time arrival information ("the next bus to Chesterton will arrive in 3 minutes") made available at bus stops, train stations, over the Internet and via teletext.

Finally, notwithstanding all the benefits which can be achieved by the teleworking, telemedicine and other initiatives described earlier in this report, the region will still need an efficient physical transport infrastructure, both to speed communications within its borders and to provide links to the UK and the rest of the world. For this reason, the Region's planning guidelines must lay out a vision which supports and encourages their improvement. For example, the regional planning guidelines could allow:

- the expansion of Stansted Airport to provide direct routes to major US destinations and to the Far East
- improvements in the existing regional rail system and suggestions for the introduction of light rail systems
- plans to upgrade the regional trunk routes, in particular the A14, which is one of the major trans-European routes linking the UK to mainland Europe.

3.4 ENTREPRENEURIAL CULTURE

As discussed in Chapter 1, in order to compete successfully with other high-tech cities and regions, Cambridge will need to develop what we have described as an entrepreneurial culture, i.e. the web of tangible and intangible elements which characterise a region's approach to doing business.

- Tangible elements include the policy of local authority planners to business development; the availability of finance from business 'angels' and venture capitalists; the level and relevance to the high-tech sector of the qualifications of the local workforce; the quality and relevance of the research undertaken by local academic institutions; the calibre of the professional services companies, such as legal firms, financial services companies and public relations companies; the quality of life for the people who live and work in the region.

- Intangible elements include the degree of networking done by local companies among themselves; the degree of networking done by local companies on a global basis; the attitude of academic institutions to entrepreneurship on the part of their staff; the attitude of established local companies to employees who leave to set up new businesses; the attitude towards failure.

All these factors are relevant to the three guidelines regarding entrepreneurial culture which are presented below. The first two deal with aspects of the tangible environment in which companies operate; the third relates to the intangible elements.

Recommendation 7: Local government should extend the definition of 'Cambridge' by designating new development land as 'Cambridge High-Tech Development Zones' and providing incentives for companies to locate there.

Local government should demonstrate its commitment to high-tech industry in Cambridgeshire and the Eastern Region by allocating significant parcels of land as designated 'Cambridge High-Tech Development Zones' (CHTDZ). This branding will be particularly important in terms of making these new development zones attractive to companies which wish to be associated with Cambridge. For the same reason, it may also be beneficial to extend the geographical area covered by the Cambridge postcode. In order to take advantage of the Cambridge 'brand', the first blocks of new development land will necessarily have to be sited reasonably close to Cambridge. The new CHTDZs could be positioned geographically in the shape of a corridor or in a number of clusters, with Cambridge positioned either at, or near, the centre in both cases.

These tracts of land will need to be supported by good ICT and physical infrastructure, providing the foundation for high-quality communications both within the buildings and to link those companies to the local region and then to the rest of the world. However, they do not need to be greenfield developments. Significant opportunities exist already. One example is the airbase at Alconbury which is located off the A1/A14 interchange, has an airstrip and could become a combined road, rail and air terminal for the Eastern Region. Other possibilities include Oakington, Cambridge Airport and the airbases at Lakenheath and Mildenhall. Obviously the housing, educational, health and transport requirements of the people living and working in these areas will also need to be taken into consideration during the development of the CHTDZs.

In order to add to the attractiveness of these zones to high-tech companies, local and central government should provide incentives for companies to locate on these developments. These could take the form of:

- **financial incentives** such as larger Capital Investment allowances, corporation tax and business rates 'holidays', and lower rents during the initial start-up phase
- **contractual incentives** such as flexible leases
- **administrative incentives** such as 'fast track' procedures to help get companies into business more quickly. For start-up companies locating in these zones, this could be crucial to getting a product into the market ahead of competitors.

An extension of the CHTDZ concept, which would also require central government involvement, would be to create 'virtual development zones', which twin CHTDZs with urban regeneration zones or places with assisted area status elsewhere in the UK. The R&D and prototyping parts of the business would be conducted in the CHTDZ, with assembly or manufacture carried out elsewhere in the UK, but the whole enterprise would be eligible for the benefits offered by CHTDZ status.

As part of the process of creating a framework for attracting and developing high-tech companies, the region will also need a ready supply of people with the business skills required to take an idea and successfully exploit it in a global market place. One way of meeting this need is suggested in the next guideline.

Recommendation 8: Players in the high-tech sector should co-operate with local higher education institutions to found a new School for Entrepreneurship.

Cambridge already has a university which leads the world in terms of the quality of its high-tech research. The School of Entrepreneurship would seek to build equivalent strength in commercial skills through three means:

- studying the local high-tech community, in order to build and disseminate a better understanding of its composition and activities
- providing relevant courses for entrepreneurs and their employees
- providing optional courses on issues involved in setting up and running a business as part of undergraduate and graduate studies, particularly for science students.

However, these efforts to build a framework which will nurture and support high-tech activity will be in vain unless the public's concerns about the impact of further growth can be allayed, hence our final recommendation.

Recommendation 9: Players in the high-tech sector must co-operate in order to present their case to policy makers and planners, and to the local community.

A key tool in achieving this goal will be the Cambridge Network initiative.[61] Cambridge Network Ltd was set up at the beginning of 1998 with two aims: to promote networking between academics, entrepreneurs, venture capitalists and professional services specialists involved in the Cambridge high-tech sector; and to promote Cambridge as a world-leading centre for high-tech innovation and development. It is entirely possible that it may find itself with a third aim, the promotion of the interests of

[61] The aims and activities of Cambridge Network Ltd are described in more detail in Annex C.

its members to decision makers at local, central and European level and to the wider community in which it lives and works. Cambridge Network and other alliances of high-tech companies should particularly seek to put their case to both government and non-government groups concerned with the future of Cambridge, including:

- the Central and South Cambridgeshire Partnership (SCP), a working party jointly funded and staffed by local government and private industry which was created specifically to try and set the agenda for the development of Cambridge – one of SCP's declared aims is to put a stop to all the *ad hoc* development that has come to characterise Cambridge's planning processes and come up with a cohesive plan that has the support of as wide a range of the population as possible
- Cambridge Futures, a grouping of business leaders, local politicians, local authority officers and academics, which is modelling development scenarios for Cambridgeshire over the next fifty years, focusing on the implications of the various geographical options for distributing growth.

3.5 NEXT STEPS

The Cambridge high-tech business community is increasingly coming to realise that the high-tech phenomenon here is at risk of being stifled from within and that its ability to compete as a leading player on the global stage may be lost. It has responded swiftly by taking steps to strengthen its identity but has so far paid scant attention to the interests and concerns of residents in the wider community.

The next challenge the high-tech community faces is therefore to convince these two constituencies of the benefits it brings to the region and the potential costs of restricting or failing to support its activities. In this context, the latest round of regional planning is critical. The regional planning guidelines will set the scene for the development of the region at a crucial point in its history.

The authors of this report believe that the Cambridge high-tech sector is on the brink of exploiting its true potential as one of the world's leading centres in ICT and biotechnology: with the right environment, Cambridge's high-tech sector can become an engine for the UK economy in the 21st century. This report has sought to demonstrate that the price of that growth need not be the destruction of quality of life. By incorporating ICT-based solutions in the toolkit of policy makers and planners, it is possible to enjoy the fruits of success without sacrificing the characteristics of Cambridge and the surrounding region which enabled high-tech industry to flourish here in the first place.

Annex A/ Economic Profile of Cambridgeshire

In order to provide further substantiation of the trends described in, and conclusions of, the report, this annex provides supporting data on economic activity (including the high-tech sector) and the quality of life in Cambridgeshire and the Eastern Region.

Although there is considerable interest in the topics discussed in this annex, the collection of data is still relatively piecemeal and inconsistent, and caution is required when interpreting and using the data. This annex does not provide any analysis of the differences in figures between the sources; instead, it seeks to highlight trends and relative changes and comparisons, rather than absolute figures.

Finally, the authors would like to thank the following for their assistance in compiling the background data used in this annex:

- Dr Elizabeth Garnsey, University Lecturer in the Department of Engineering and the Judge Institute of Management Studies, University of Cambridge
- Richard Lewney and Saxon Brettell, Cambridge Econometrics
- Jill Tuffnell, Head of the Cambridgeshire County Council Research and Information Unit.

A1 HIGH-TECH INDUSTRY IN CAMBRIDGESHIRE

This section explores two hypotheses which are at the heart of this report:

- that high-tech industry in Cambridgeshire is maturing
- that high-tech industry is a major engine of growth for Cambridgeshire and the Eastern Region.

In order to provide as complete as possible a profile of the nature of high-tech industry in Cambridgeshire we have used data from a variety of sources.

- Cambridgeshire County Council has published reports about high-tech industry in the county in 1993 and 1995. Its most up-to-date data is based on a survey of over 1000 companies conducted in 1996.
- Cambridge Econometrics, a consultancy which provides economic forecasting services for business and government, has undertaken a great deal of modelling of the UK economy and the regions.[62]
- Elizabeth Garnsey, together with two colleagues at the Judge Institute, published a paper in 1997 on recent developments in the high-tech sector entitled 'The Cambridge Phenomenon Comes of Age'.

However, constructing a consistent definition of 'high-tech industry' is fraught with difficulty, as the different sources use varying sub-sets of Standard Industrial Classification Codes. Thus, Cambridgeshire County Council employs a broad definition including the development, production and marketing of services and products classified as high-tech. Cambridge Econometrics uses the broadest definition of high-tech, consistent with its modelling of the UK economy as a whole; its figures are therefore higher than those provided by the other sources, but allow comparison of activity in Cambridgeshire with that in other counties in the Eastern Region and other UK regions. The group at the Judge Institute of Management Studies has adopted the narrowest definition of high-tech industry, generating the smallest totals for the number of firms and employees – these figures form the basis of much of this analysis.

A1.1 High-tech industry in Cambridgeshire is maturing

Several reports have been written on the subject of the 'Cambridge Phenomenon', the period of rapid growth in the number of high-tech firms in Cambridge between the 1960s and the mid-1980s. This section examines whether it is possible to discern any recent changes in the number, and particularly the size, of companies active in high-tech industry in the county which would indicate that they are maturing to a point where they have the scale of human and financial resources needed to compete in global markets.

Figure A1 shows the evolution of the total number of companies in the high-tech sectors between 1988 and 1996. This suggests that the number of companies continued to grow into the early 1990s, before tailing off slightly from 1994. This was the result of a significant decline in the number of start-ups, a slight increase in the number of companies moving out of the region, and a largely stable number of companies failing.

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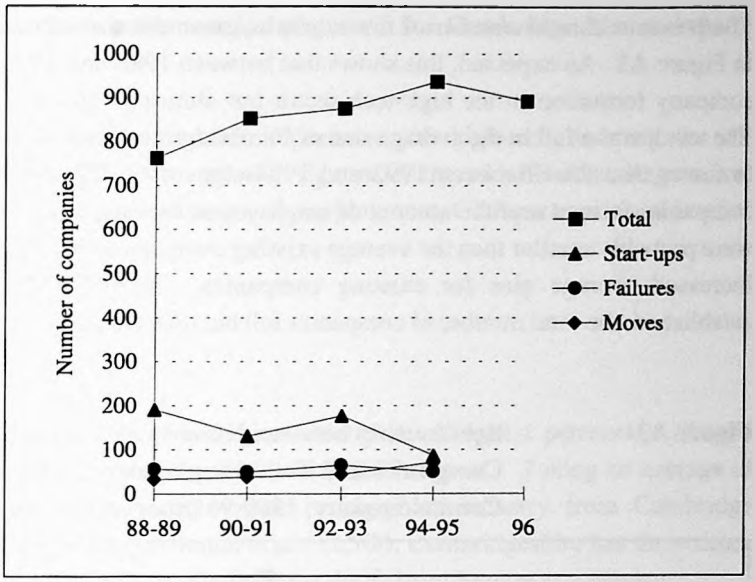
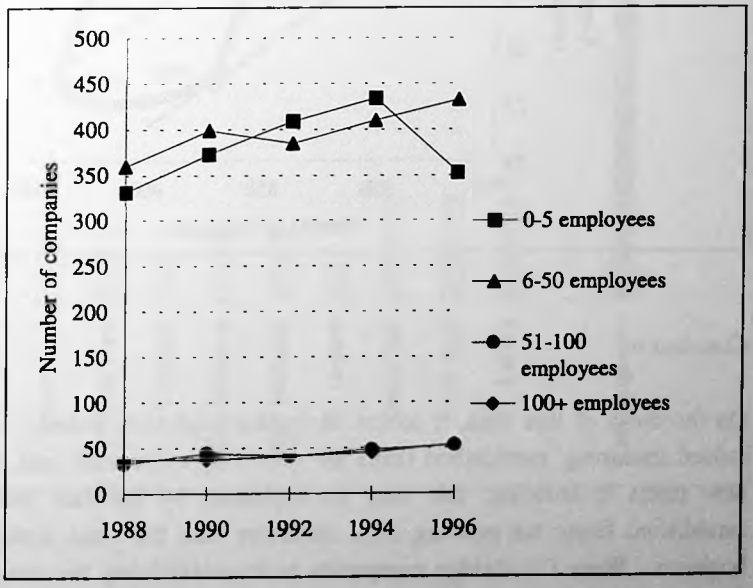
62 http://www.camecon.demon.co.uk

Figure A1/ Total High-tech Companies in Cambridgeshire, 1988-96 [Source: Gonzales-Benito *et al* (1997)].



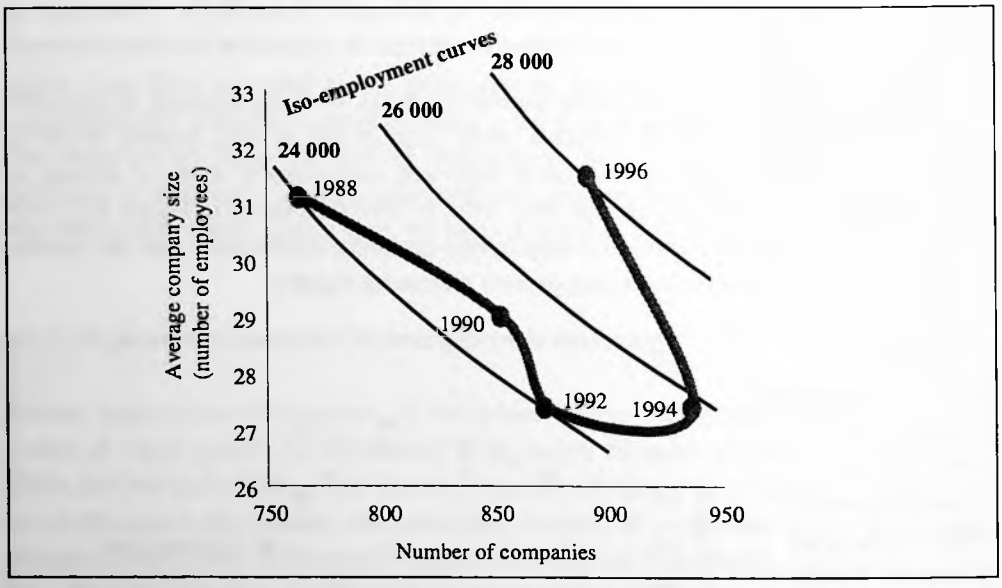
In contrast, despite the decline in the number of firms, total employment in high-tech industry has increased sharply in recent years, from 24 000 in 1992 to over 28 000 in 1996. Thus, when looking at the size of high-tech companies in terms of number of employees, there is a marked change from 1994 to 1996 (illustrated in Figure A2), with the number of small companies (0–5 employees) declining significantly, and the number of medium-size companies (6–50 employees) increasing steadily.

Figure A2/ Size of Companies in High-tech Industry in Cambridgeshire, 1988-96 [Source: Gonzales-Benito *et al* (1997)].



The previous data on number of firms, employment and size of businesses are combined in Figure A3. As expected, this shows that between 1988 and 1992 there was a flurry of company formation in the high-tech sector but almost no growth in total employment. The result was a fall in the average size of Cambridge companies from over 31 employees to fewer than 28. Between 1992 and 1994 signs of a different trend emerged; more companies formed *and* the amount of employment increased. Since the new companies were probably smaller than the average existing companies, this indicated a trend towards increased average size for existing companies. By 1996 this trend had become established; the total number of companies fell but total employment grew rapidly.

Figure A3/ **Relationship between Number of Companies, Average Size of Companies and Total Employment in High-tech Industry in Cambridgeshire, 1988-96 [Source: Analysys].**



Conclusion

On the basis of this data, it seems likely that high-tech industry in Cambridgeshire is indeed maturing: established firms are recruiting more staff and, while the creation of new firms is slowing, this may be explained by the fact that opportunities with established firms are proving more attractive than the risks associated with starting a business. Were Cambridge companies to be maintaining the same average size, or be declining in size this might indicate rapid innovation, but would not point towards Cambridge increasing or even maintaining its activities on a global scale.

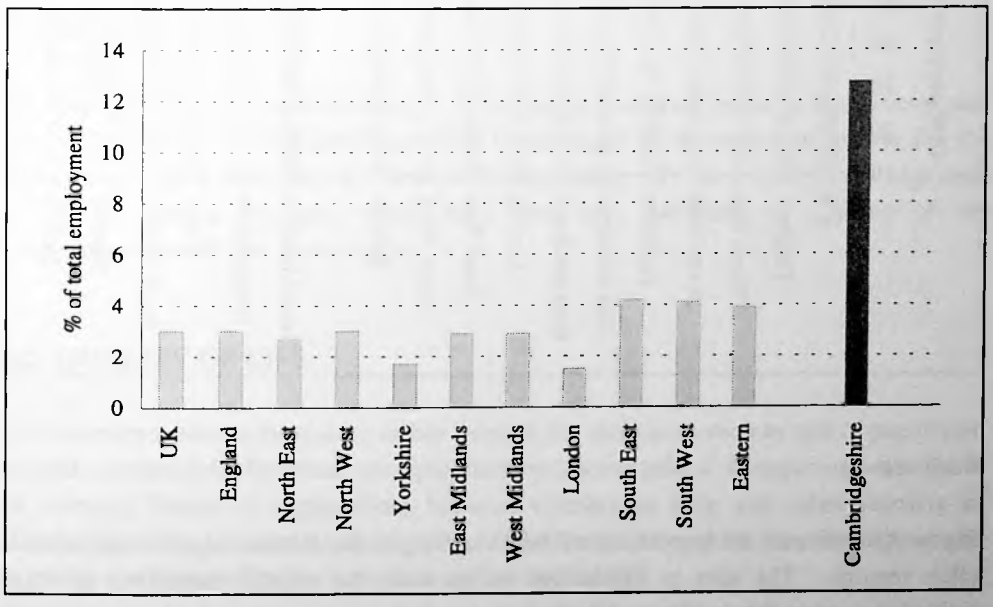
A1.2 High-tech industry is a major engine of growth for Cambridgeshire and the Eastern Region

To test this hypothesis, data on the importance of high-tech industry to the Cambridgeshire economy was compared with figures for the wider Eastern Region, and other UK regions. The criteria examined were employment, GDP per capita and level of R&D activity.

Employment

As Figure A4 illustrates, the Eastern Region has the third highest percentage of total workforce employed in high-tech industry of all the UK regions. Taking an average of the data on the percentage of employment in high-tech industry from Cambridge Econometrics (15%) and Gonzales-Benito *et al* (12.5%), Cambridgeshire has three times as many people employed in high-tech industry as the Eastern Region as a whole.

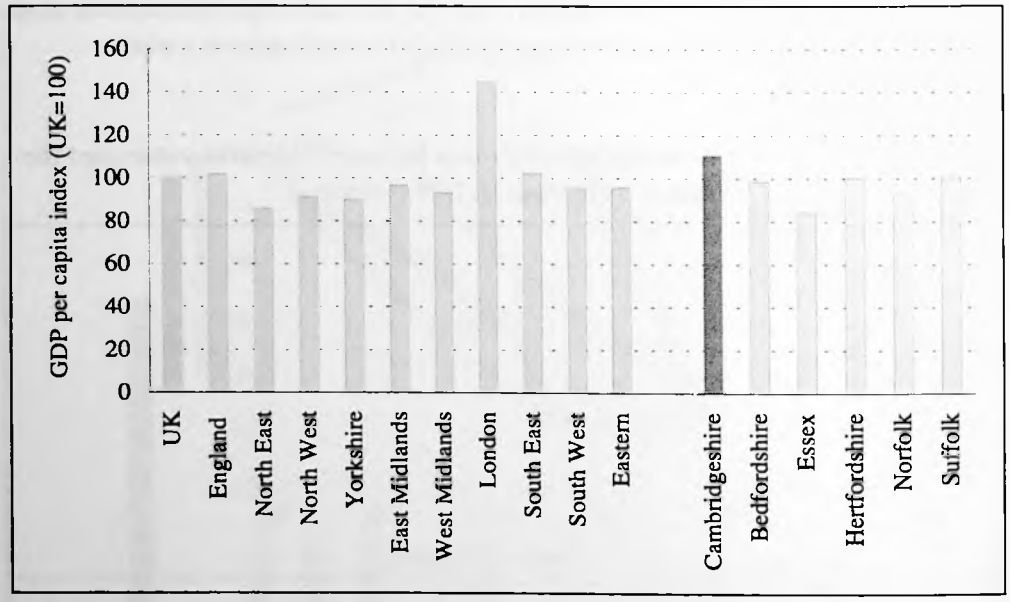
Figure A4/ **Employment in High-tech Industry, Cambridgeshire and the Regions, 1995 [Source: DTI (1998)].**



GDP

To measure the importance of high-tech industry in terms of GDP, we first examined the value added by high-tech industry in Cambridgeshire to the total value added for Cambridgeshire. According to Cambridge Econometrics' forecasts, the contribution of high-tech industry to the total industrial value added was 18.6% in 1991 and is forecast to grow to 24% in 2000. This concentration in value added is reflected in Cambridgeshire's GDP per capita performance, which significantly higher than in any region but London, as illustrated in Figure A5. However, the Eastern Region as a whole is below the UK average.

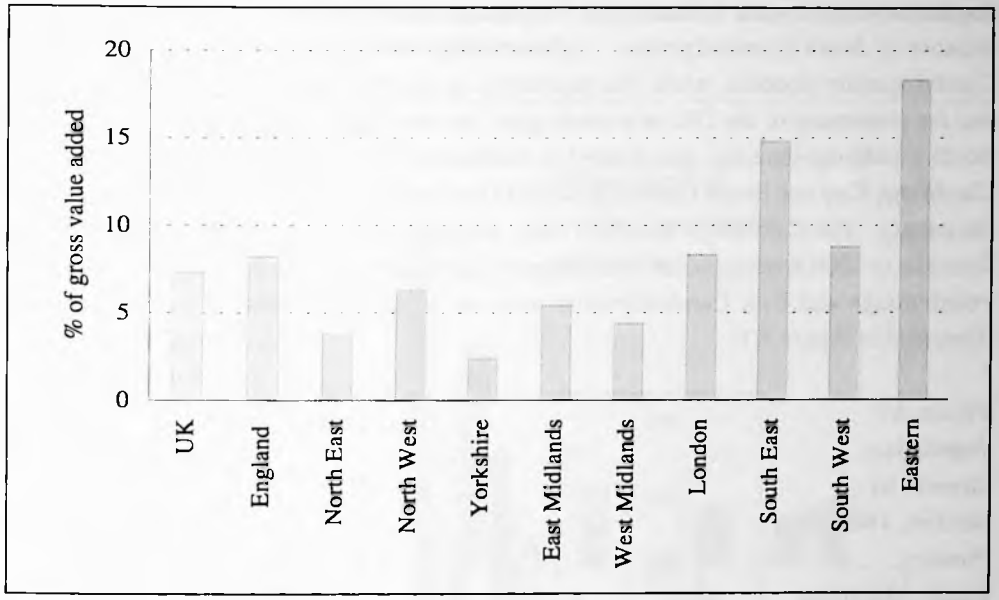
Figure A5/ **GDP per Capita Index (UK=100), 1993 [Source: Office of National Statistics (1997a)].**



R&D activity

Figure A6 indicates the importance of R&D activity in the Eastern region compared to other regions. The data in Figure A6 is based on the OECD definition of 'high technology', as is that in Figure A4; the high level of employment in high-tech industry in Cambridgeshire shown in Figure A4 suggests that the major concentration of R&D activity in the Eastern Region is likely to be around Cambridge City and South Cambridgeshire. However, the benefits of this R&D are available to be exploited by the region, and by the UK as a whole.

Figure A6/ **Business Enterprise R&D for Manufactured Products as a Percentage of Gross Value Added, 1995 [Source: DTI (1998)].**



Conclusion

As high-tech industry is becoming an increasingly-important factor in the national and global economy, so Cambridgeshire will increasingly be an engine of growth for the immediate region and the UK. Both will increasingly rely on growth in the high-tech sector to replace the jobs which have been lost elsewhere as a result of the implementation of new technology.

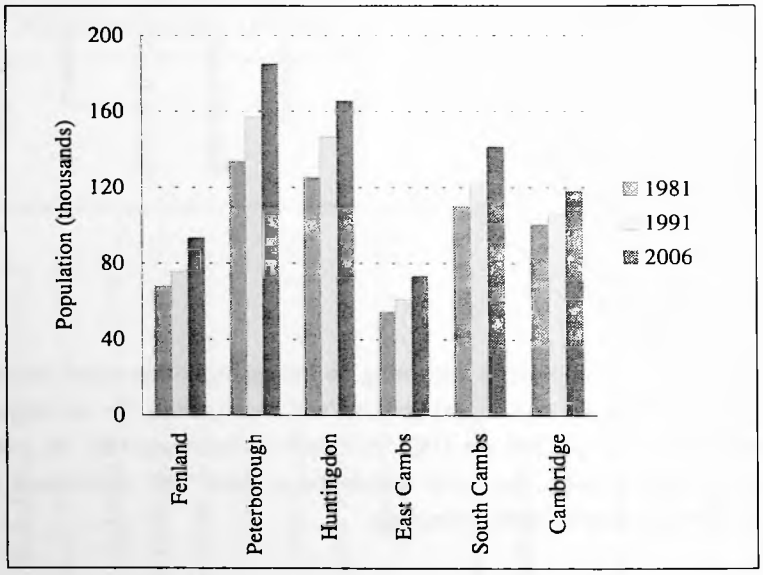
A2 QUALITY OF LIFE

This section assesses the quality of life through key indicators such as rate of population growth, commuting distances, unemployment and house prices. Comparisons are drawn at varying levels of aggregation: between Cambridge City and other districts in Cambridgeshire; between Cambridgeshire and other counties in the Eastern Region; and between the Eastern Region and other regions in the UK.

Population Growth

As discussed in Chapter 1, Cambridge City has shielded itself from growth largely at the expense of South Cambridgeshire. Between 1950 and 1996, the population of South Cambridgeshire doubled, while the population in the City rose by approximately 34% and the population of the UK as a whole grew by only 12%. However, in recent years, South Cambridgeshire has also started to shield itself from growth – the population in Cambridge City and South Cambridgeshire has increased more slowly than in the rest of the county. The Cambridge Structure Plan, which incorporates both historical data and forecasts to 2006 envisages that this pattern of development will continue, with Fenland, Peterborough and East Cambridgeshire now set to bear the brunt of development, as illustrated in Figure A7.

Figure A7/ Population Growth by District, 1981-2006 [Source: Cambridgeshire County Council (1995b)].



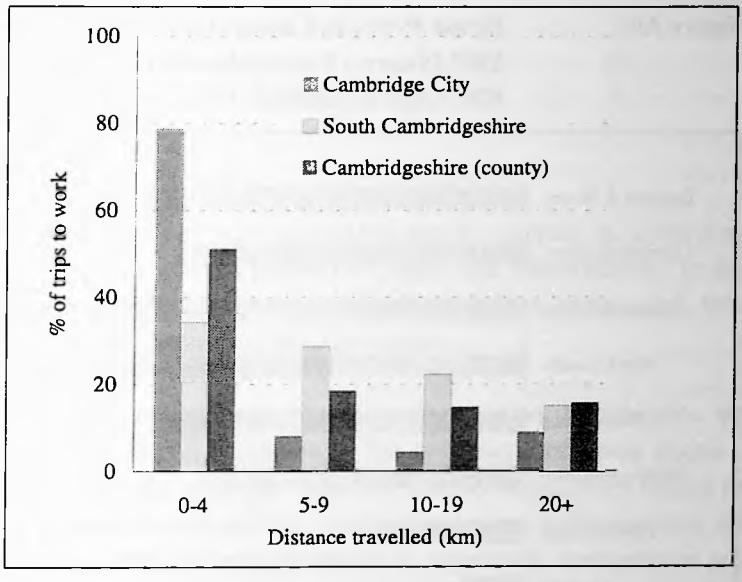
Commuting Distances

The average distance travelled to work in the Eastern Region is the highest in the UK (17km) and the average time taken (25 minutes) is second only to London.[63] However, there are wide variations in travel patterns, as illustrated in Figure A8 for Cambridgeshire. Commuting distances are notably shorter for Cambridge City residents than for the population of the county as a whole, and notably longer for residents in South Cambridgeshire, many of whom either travel into Cambridge to work, or out of the county. As noted in Chapter 1, the Cambridgeshire Structure Plan assumes that this

63 Department of the Environment, Transport and the Regions (1997a).

trend of commuting into Cambridge City will continue and deepen, hence it is likely that both the average distance travelled to work by Cambridgeshire's population and the time they spend commuting is likely to increase in future unless more effective transport solutions and working patterns are implemented.

Figure A8/ Distance Travelled to Work by Cambridgeshire Residents, 1991 [Source: Cambridgeshire County Council (1995a)].



Unemployment

Unemployment in the Eastern Region is low (3.9% of economically-active people compared to 5.2% for the UK as a whole) and is particularly low in Cambridgeshire (2.8%). However, this masks considerable variation, particularly in terms of the long-term unemployed: the long-term unemployed accounted for 33% of total unemployed claimants in the country in January 1997, compared to 36% for the UK as a whole, but for 40% in Cambridge City and only 27% in Huntingdonshire.[64]

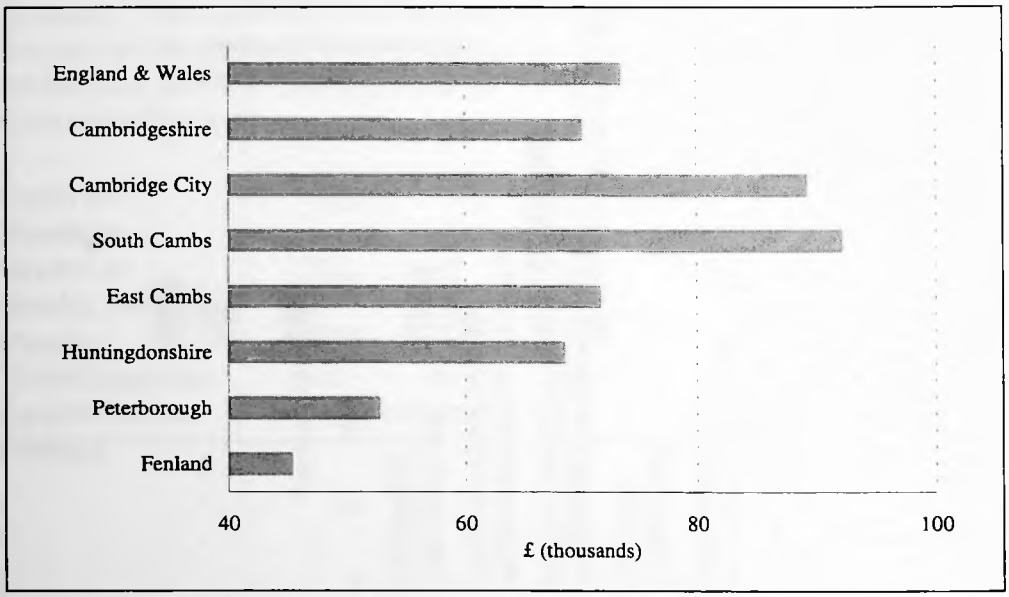
House Prices

As discussed in Chapter 1, the impact of development pressures on Cambridge and its immediate vicinity has become particularly obvious in the housing market, in the form of wide discrepancies across the county. For example, at the beginning of 1998, the average price of a semi-detached house in Cambridge was £100 350, whereas a similar house in Peterborough cost just £49 250. Moreover, whereas the price of all types of

64 Office of National Statistics (1997a).

houses in the county was slightly less than that for England and Wales as a whole, in Cambridge and South Cambridgeshire it was at least £10 000 pounds more, as shown in Figure A9.

Figure A9/ **House Prices in Cambridgeshire, by District, First Quarter of 1997 [Source: Cambridgeshire County Council (1997b); HM Land Registry].**



Conclusion

The data reflects Cambridgeshire's status as a centre of growth and prosperity in the Eastern Region (confirming the conclusions of Section A1). However, the quality of life for many is under threat as a result of the pressures of development. As the county grows in prosperity so more and more claims are being made on scarce resources. The long journeys to work which many employees make, and the disparity in house prices across the county, indicate that many residents cannot afford to live close to their work. If employment and development are concentrated in a few rapidly-growing centres then this trend – and the associated impacts on quality of life – will become more marked, and must eventually have a limiting effect on further economic growth.

Annex B/ The Digital Revolution

Telecoms is characterised not only by rapid change but also by complexity, in the form of rapidly-developing technologies and a plethora of jargon and abbreviations. In this annex we explain the major technological developments in the sector, and their implications for the information economy of the 21st century.

The changes being wrought in information and communication technologies are sometimes referred to as 'the digital revolution'. The importance of going digital – coding all communications into the same bits and bytes used by computers – cannot be understated. Once the waves of sound and light which form human communication are converted into digital signals, they become susceptible to processing, manipulation and storage by computers. Instead of relying on specialist devices for handling sounds and images, computers and networks can now handle all forms of communication, and provide faster and cheaper access to information and communication services.

Until very recently the power of computers was increasing more rapidly than the capacity of communications networks. The practical implication of Moore's Law – which states that the power of integrated circuit chips doubles every 18 months – has been to create an environment in which computers are islands of powerful functionality connected by only the thinnest of communications links. However, the evolution of telecoms technology is now being driven by the same forces which are driving computing. The relentless increase in processing power is enabling communications networks to carry greater amounts of information, at higher speeds.

But this is only half the story; the links themselves now use different technologies – the new technologies of light represented by optical fibre. And use of optical fibre means that communications is now subject to a greater rate of change than computing has ever been. The combination of Moore's Law and optical technologies is leading to the prospect of limitless cheap communications, and the ability to link information processing throughout the world at low cost will have far reaching consequences.

Optical fibre and opto-electronics

Since emerging from the laboratories in the early 1980s, optical fibre has revolutionised the costs of communication by providing undreamed-of capacity – a single fibre is now able to carry more than 100 000 telephone calls or 1000 television channels simultaneously (billions of bits per second). Moreover, the development of this technology shows no sign of slowing down. Fibre is currently augmented by repeaters, costly devices needed every 20km or 30km to regenerate faded signals, but within a few years fibre capable of transmitting up to 500km without the need for repeaters will be available. One effect of this breakthrough will be to slash the cost of submarine cable, laid to carry international calls, by removing the need for these repeaters to be placed underwater.

The drawback of optical fibre is the cost of the equipment needed to turn the 'bits' of the electrical network into pulses of light and vice versa. The technology of opto-electronics could solve this problem by keeping the signals as light and, moreover, would enable the development of smaller devices, capable of processing information even faster than today's electronics. A fully-optical network with optical computers would make today's system looks like a combination of mechanical calculators and Morse Code across telegraph.

However, until an all-optical network is possible, expensive conversion will still be needed. This means that optical fibre cannot be cost competitive with copper wires for low capacity communications because the relatively few bits being transmitted have to carry the cost of the expensive equipment at each end. So while optical fibre has swept copper cable from the long-distance networks, copper remains in place for what is known as 'the first mile' – the connection between the customer and the main network. Here we meet one of the great strategic issues facing telecoms operators: based on current demand it is not possible to justify replacing copper with optical fibre; and yet, if this were done it could potentially unleash such a huge jump in usage that the investment could be justified. The problem has been compared to trying to estimate the size of a road bridge required to cross a ravine based on looking at the number of people using a rope bridge. It is an expensive gamble to take, and operators reluctant to take the risk have been looking at ways of providing higher bandwidths over their existing copper infrastructure, as described below.

Digital subscriber line technology

Many computer users are familiar with the way that modem performance has improved dramatically in the recent past: 33kbit/s and now 56kbit/s modems are cheap and widely available. However, these improvements are pushing analogue technology to its limits. Digital subscriber line (DSL) technologies, which apply computing power to each end of a copper wire and process the electrical signals, allow operators to obtain much more capacity than is available from analogue signals. 2Mbit/s and even 8Mbit/s now seem to be within economic reach and, better still, DSL 'modems' can be installed on demand customer-by-customer rather than having to provide optical fibre cable to entire areas.

Although DSL technology does not have the capacity of optical fibre, it turns the flimsy 'rope bridge' of copper into something capable of carrying real traffic – such as television or truly high-speed Internet access – and acts as a vital intermediate stage. By studying demand for DSL, operators can then make more informed investment decisions about when and where to deploy optical fibre.

Mobile communications

The spectacular growth of cellular mobile communications has been obvious in recent years. Networks based on digital technology – second-generation systems – have now surpassed first-generation (analogue) technology because of a number of inherent advantages:

- transmissions are more secure because of digital encryption which identifies the user and encodes the conversation
- the quality of sound is better
- it is possible to use the same telephone when travelling abroad
- the handsets can send and receive digital information, providing word processing, diary, spreadsheet, email facilities and Internet access, as well as voice and data communications
- the handsets themselves are smaller and lighter.

However, although second-generation digital cellular mobile has been spectacularly successful, with over 100 million users worldwide, it has limitations, particularly in the rate at which it can send and receive information. The emerging third-generation standard – known as Universal Mobile Telecoms Service (UMTS) – is designed to overcome these problems. Instead of being restricted to 9.6kbit/s (which is good enough for voice and slow data transmission), users will be able to get at least 64kbit/s (which is

adequate for videotelephony and downloading WWW pages). When using mobile devices within buildings equipped with UMTS base stations, users will get up to 2Mbit/s, which is enough for many computer applications. And new 'Hyperlan' radio-based equipment will provide 25Mbit/s and above. Mobile phones, and palmtop and laptop computers will be packaged as one device which will be usable almost anywhere and cables attaching computers to networks will rapidly become a thing of the past.

Radio and satellite communications

The growth of mobile cellular communications is perhaps the most visible sign of changes which have been taking place in radio communications, but it is also increasingly possible to economically use higher and higher frequencies. This ability is hugely important because the higher reaches of the radio spectrum are a vast and currently untapped resource – offering more capacity than is used by all existing broadcast radio, TV and mobile communications combined.

Radio has some significant advantages over fixed communications. Unlike cable systems, which require entire areas to be covered before any one customer can be connected, the connecting equipment for radio systems only goes in when and where it is needed. Radio is also very flexible, with installation or removal affecting only the respective ends of a link rather than having to deal with intervening ducts and cable. For relatively little expense, a base station (radio transmitter/receiver) can be used to provide service to a wide area more quickly and more cheaply than cable (depending on the density of customers).

The ultimate base station is the satellite. Placing the radio transmitters/receivers in space rather than on the ground enables large areas to be provided with services, and the advent of digital technology has greatly increased the capacity of these systems. To date, satellite services have mostly been directed at fixed users, but more recently ambitious systems have been developed for providing mobile communications anywhere in the world through a network or mobile base stations in the sky. Within the next five years a new generation of 'Low Earth Orbit' satellites will begin to be launched, with systems comprising tens and even hundreds of satellites. Sophisticated electronics in the satellite and on the ground will enable users to communicate at 64kbit/s per second, 2Mbit/s per second and beyond – from anywhere to anywhere.

Networks and networking

While the fixed and mobile technologies described above open up the possibility of previously undreamed-of capacity, there remains the problem of how to use it. Communications standards need to be defined so that people and equipment can actually communicate with each other. Standards – the 'rules of the road' in telecoms – cover a vast range of techniques but boil down to simple basic principles of how to make the most effective and efficient use of the physical network. One of the complicating factors in understanding this area of communications is that standards are not necessarily substitutes for each other, and many may need to be used together to work effectively.

Traditionally in telecoms, a circuit is fully allocated between two points for the duration of a communication session, but in recent years 'packet-switched' technologies have been developed. These technologies group bits into parcels ('packets') which consist of the information content of the communication plus addressing details for delivery of the packet. This technique has several advantages over traditional approaches: for example, if the data from one source is 'bursty' (short periods of intense use interspersed by periods with no traffic) then packets from other users can be interleaved in the gaps.

The Internet Protocol (IP) is the best-known packet-based transmission technique. IP has one additional advantage which has enabled the Internet to grow at an astonishing rate: if part of the network is congested or removed, the packets continue to flow (albeit perhaps more slowly) across alternative routes. The amazing corollary of this is that adding capacity almost anywhere in the network increases the capacity of the network as a whole, without the need for detailed capacity planning. Uncontrolled and unplanned growth is not the danger to the Internet that it would be with other kinds of networks and this has meant that the Internet has been able to grow at a rate unprecedented in the history of communications.

Terminals

Attention is increasingly turning to the means by which customers will choose to access these communications resources. Businesses are likely to continue to rely on the PC, but the evolution of intelligence within the network creates another possibility – the 'network computer' concept. This envisages a powerful computer with no permanent local storage (i.e. no hard disk) which downloads an operating system from a network server when switched on and loads applications over the network on demand. Instead of having to take your terminal, with your information, it would be possible to walk up to a terminal anywhere and access 'your computer', presented to you almost instantaneously in exactly the same state you left it perhaps thousands of miles away.

The same kind of thinking is being applied to ordinary consumers, through the medium of the 'set-top box'. The set-top box is an access and security control device on cable TV and satellite networks. Today, analogue set-top box technology is used to connect satellite-TV and cable-TV subscribers to those networks and to manage 'conditional access' for pay-TV services. Limited functionality includes facilities for switching between channels and, in some proprietary systems, the ability to select alternative camera angles for sporting coverage. Digital set-top box technology is more sophisticated, providing decoding and decompression facilities for more than 200 channels, which can carry other forms of interactive service in addition to broadcast programming. A set-top box with sufficient computing power could transform one or more family TVs into Internet terminals and be capable of co-ordinating activities such as video on demand, videotelephony, and a home-learning station.

Annex C/ Cambridge Network

The Cambridge Network aims to create and support a community of like-minded people from business and academia in the Cambridge region, and link this community to the global high-tech network.

Cambridge Network Ltd was founded in March 1998 by 3i, Amadeus (a new venture capital fund created to support early stage technology companies with global potential), Analysys Limited, Arthur Andersen, NW Brown and Co, and the University of Cambridge. Sir Alec Broers, Vice Chancellor of the University, is Chair of the company. To date, more than 30 companies have applied to become founder members.

Cambridge Network has two projects underway in addition to Cambridge 2020:

- creating a WWW site to promote Cambridge as a centre of high-tech excellence and provide a networking infrastructure which will benefit the members of the Cambridge Network. The site will include a news service, directories of Cambridge high-tech companies and a 'technology bazaar' for companies which wish to find manufacturers, licensees or funding for their products. The site will be launched in June 1998.[65]
- organising a three-day visit to Cambridge on the theme of 'Influencing the Future' for US industry media, market research analysts and the venture capital community. Representatives from organisations such as the Wall Street Journal and BancAmerica will attend a series of company visits, product demonstrations, and technology presentations in a variety of industry segments, including data communications, graphics processors and digital technology for mobile communications.

In addition, it is planning a speaker programme for its regular meetings.

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[65] http://www.cambnet.co.uk

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http://www.camcnty.gov.uk/index.html	Cambridgeshire County Council
http://www.detr.gov.uk	Department of the Environment, Transport and the Regions
http://www.coi.gov.uk	UK Central Office of Information
http://www.ehto.be	European Health Telematics Observatory
http://www.edc.eu.int	European Digital Cities (EU project)
http://www.tagish.co.uk/ethos/default.htm	European Telematics Horizontal Observatory Service

http://www.eto.org.uk	European Telework Online
http://www.hop.co.uk	Home Office Partnership, Cambridge-based consultancy specialising in flexible working
http://www.challenge.stockholm.se	The Global Bangemann Challenge
http://www.mdc.com.my/msc/index.html	Malaysian Multimedia Super Corridor
http://www.mediation.co.uk	Mediation Technology, Cambridge-based consultancy specialising in the use of IT for business, education and voluntary organisations
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http://www.nhs50.nhs.uk/home.htm	National Health Service
http://www.open.gov.uk	UK Government Information Service
http://www.saem-sophia-antipolis.fr	Sophia Antipolis WWW server
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